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13. ABSTRACT *(Maximum 200 words)*

The sixth meeting of T2TG was held on 24-25 Mar 92, at Phoenix AZ. It was hosted by Armstrong Laboratory Williams AFB. Dr. William Howell, AL/HRD spoke about situational awareness as it relates to aircrew performance.
Mr. Denis Breglia, NTSC, described issues surrounding development and use of virtual environments as training technologies. Dr. Michael Drillings, USARI, discussed findings of ARI sponsored National Research Council reports on value of "non-mainstream" training techniques for US Army training. Training Technology demonstrations at Williams Air Force Base, Armstrong Laboratory included night vision devices, MULTIRAD (simulator) and visual color modeling. During the Steering Committee meeting it was decided that we should encourage our respective laboratories to view T2TG as a mechanism for implementing TAPSTEM. Changes in the chairmanships of subgroups will take place next year: the Navy taking over Advanced Technologies, and the Army assuming chairmanship of the Crew, Group and Unit subgroups. In addition, the chair of the Steering Committee will rotate from the Army to the Navy following next year's meeting.

14. SUBJECT TERMS

Situational awareness, development and use of virtual environments, non-mainstream training techniques

15. NUMBER OF PAGES

362

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DOD Training Technology Technical Group (T2TG) Minutes

The sixth meeting of the DOD Training Technology Technical Group (T2TG) was held on 24-25 March 1992, at Phoenix Arizona. It was hosted by Armstrong Laboratory, Williams Air Force Base.

There were three keynote presenters. Dr. William Howell, AL/HRD spoke about situational awareness as it relates to aircrew performance. Mr. Denis Breglia, NTSC, described the issues surrounding the development and use of virtual environments as training technologies. Dr. Michael Drillings, of the Basic Research Office, USARI, discussed the findings of ARI sponsored National Research Council reports on the value of "non-mainstream" training techniques for U.S. Army training. Training Technology demonstrations at Williams Air Force Base, Armstrong Laboratory included night vision devices, MULTIRAD (simulator), and visual color modeling.

During the Steering Committee meeting, it was decided that we should encourage our respective laboratories to view T2TG as a mechanism for implementing TAPSTEM. Changes in the chairmanships of subgroups will take place next year: the Navy taking over Advanced Technologies, and the Army assuming chairmanship of the Crew, Group, and Unit subgroups. In addition, the chair of the Steering Committee will rotate from the Army to the Navy following next year's meeting.

The next meeting is scheduled for 4-5 May 1993. It will be hosted by the Army Research Institute in Orlando, Florida.

The following pages provide the agenda, subgroup summaries, hardcopies of the viewgraphs, and the list of attendees.

ROBERT J. SEIDEL, Ph.D.
Chief, Automated Instructional Systems,
U.S. Army Research Institute
Chair, T2TG

AGENDA

6th DoD TRAINING TECHNOLOGY TECHNICAL GROUP

24-25 March 1992

<u>TUESDAY, 24 MARCH 1992</u>

0700 - 0800 Registration/Fees

<u>PLENARY SESSION I</u>

0800 - 0810 Commander's Welcome
(Lt Col Lynn Carroll)

0810 Aircrew Training Research Division Overview

0830 Administrative Support Announcements
(Ms Linda Swan)

0845 - 0900 Introduction of Invited Speakers
(Dr Bob Seidel, ARI)

0900 - 0940 Situational Awareness
(Dr William Howell, HR Directorate Armstrong Laboratory)

0940 - 1020 Enhancing Human Performance
(Dr Michael Drillings, ARI)

1020 - 1050 Coffee Break

1050 - 1130 Virtual Environments
(Mr. Denis Breglia, NTSC)

1130 - 1300 LUNCH

SUBGROUP SESSION I

<u>Advanced Training Technology</u>

Introduction and Administrative Issues Subgroup Theme: Simulator, Simulations and "Virtual Reality"

Enhancing Aircrew Training Through Virtual Environment Research (Dr. Richard Thurman, USAF AL/HRAU)

Research on the Use of Virtual Environments in Crisis Management in the Navy (Ms. Janet Dickieson, NPRDC)

Behavioral Requirements for Training in Virtual Environments (Dr Bruce Knerr, USARI)

Crew, Group, Team, and Unit Technology Sub-Group

Opening Remarks

Joint Collective Training R&D Effort
- Dr Frank Moses, ARI
- Dr Eduardo Salas, NTSC
- Discussion (All)

Training Design & Evaluation

Welcome and Administrative Issues

Training Needs and Evaluation Issues
- Identifying Over-and-Under-Trained Tasks (Ms Morales)
- Opportunities to Perform Trained Tasks (Dr Mark Teachout)

Roundtable Discussion (ALL)

1600 Adjourn from Subgroup Location

1700 - 1900 No Host Bar with Heavy Hors d'Oeuvres - Resort's Lounge

WEDNESDAY, 25 MARCH 1992

SUBGROUP SESSION II

Advanced Training Technology

Visual Learning in Virtual Environment (Dr J. Psotka, ARI)

Summary and Conclusions of Virtual Reality in Training Research in the Services or "What are the Research Issues in the use of Virtual Reality in Training?"

Roundtable Discussion

Crew, Group and Unit Training

Aircrew Coordination Training R&D
- Dr David Baker, NTSC
- Mr Randall Oser, NTSC
- Major Wes Woodruff, USAF, NTSC
- Discussion (All)

Training Design and Evaluation

Instructional, Planning and Evaluation Issues
- Modeling Skill Acquisition (Dr Sabol)
- Retention of Knowledge Learned in College (Dr Ellis)

Roundtable Discussion (ALL)

0945 - 1000 BREAK

SUBGROUP SESSION III

<u>**Advanced Training Technology**</u>

Basic Job Skills Job Family Tutor
(Dr Ellen Hall, USAF-AL/HRMJC)
Issues in Designing and Intelligent, NLP-based Tutor for Foreign Languages (Dr Michelle Sams, USARI)

Summary and Conclusions

<u>**Crew, Group and Unit Training**</u>

Update of AF ISD Process
- Major Conrad Bills, ASD/YTEE

Team Decision-Making Training (Update)
- Eduardo Salas

Discussion (All)
- Next Meeting
- Topics
- Format
- Product(s)

<u>**Training Design and Evaluation**</u>

Instructional, Planning and Evaluation Issues
- Instructional Strategies for Logistic Command and Control (Captain Hioki)
- Distance Learning (Mr Gettman)

Roundtable Discussion (ALL)

1145 - 1245 LUNCH

1245 Bus departs Conference Center

1300 Arrival Williams Air Force Base, Armstrong Laboratory

1300 - 1500 DEMONSTRATIONS

GROUP 1	DEMOS	GROUP 2
1305 - 1325	Night Vision Devices & Training (Bldg 558)	1435 - 1500
1335 - 1400	MULTIRAD (Bldg 561)	1405 - 1425
1435 - 1500	Visual Systems Color Modeling (Bldg 558)	1305 - 1325
1510	Bus departs Williams Air Force Base	
1525	Arrival Conference Center	
1530 - 1630	Wrap-Up	

PLENARY SESSION I

DR. WILLIAM HOWELL

HR Directorate Armstrong Laboratory

SITUATIONAL AWARENESS

AIR FORCE SYSTEMS COMMAND

DR WILLIAM C. HOWELL
HUMAN RESOURCES DIRECTORATE
ARMSTRONG LABORATORY

OVERVIEW

- WHY SA BECOME HOT ISSUE
  - WHY DON'T HAVE HANDLE ON IT
  - WHY COULD BE USEFUL IF D<u>ID</u>
- WHAT THE LITERATURE TELLS US
  - THEORETICAL ISSUES
  - MEASUREMENT ISSUES
  - RESEARCH ISSUES
- WHAT AF IS DOING
  - SAINT INITIATIVE (NOW)
  - AFOSR 6.1 INITIATIVE (FY94)
- SUMMARY

COORDINATED ATTACK ON SA

MAIN FOCI:	PREDICTION DEVELOPMENT	SA CONCEPTUALIZATION AND INDEXING	PERFORMANCE CRITERION MEASUREMENT
MAIN ISSUES:	● WHAT TRAITS UNDERLIE SA? ● SA ACQUISITION?	● WHAT IS SA? ●● BOUNDARIES? ●● FACETS?	● WHAT DOES SA DO FOR YOU? ●● "GLOBAL" SA? ●● FACETS OF SA?
MAIN ACTIVITIES:	TEST DEVELOPMENT, VALIDATION AND CUSTOMIZATION	● THEORY DEVEL. AND TEST ●● EXPERIMENTS ●● SME INPUTS ● MEASUREMENT TECHNIQUES	● PILOT MEASURES ●● TRAINING ●● COMBAT EFFECTIVENESS ●● SPATIAL ORIENTATION ● OTHER CONTEXTS ●● C^3I (AESOP)
MAIN LINKS:	PREDICTOR-SA CORRELATION →		
	PREDICTOR-PERFORMANCE CORRELATION →		
		SA-PERFORMANCE CORRELATION →	
ANTICIPATED PRODUCTS:	● VALID SELECTION DEVICES ●● FOR SA ●● FOR SA FACETS ●● IN BATTERIES	CONTENT/CONSTRUCT-VALID SA INDEXES SA TRAINING PRINCIPLES	REQUIREMENTS FOR TRAINING SYSTEMS OPERATIONAL SYSTEMS REQUIREMENTS

HOWELL.03

BACKGROUND

DEFINITION OF SA:
"MILITARY OPERATORS' KNOWLEDGE OF IMMEDIATE TACTICAL SITUATION."

--Sarter & Woods, 1991

OPERATIONAL PROBLEM

- INCREASING INFORMATION-PROCESSING DEMANDS (COCKPIT & ELSEWHERE)
- MISHAP ATTRIBUTION (80% OF OPS CLASS A)
- AIR STAFF CONCERNS (PAT)
- FRAGMENTATION OF KNOWLEDGE; LIMITED SUCCESS OF INTERVENTIONS

CONCLUSION: NEED EXISTS, AS DOES POTENTIAL FOR SIGNIFICANT R&D CONTRIBUTION

HOWELL04

BACKGROUND (Cont.)

RESEARCH PROBLEM

- HARD TO DEFINE SA PRECISELY
  - STRONG, YET DIFFERENT OPINIONS ON MEANING
  - EVIDENCE SUGGESTS MULTIFACETED CONSTRUCT
- HARD TO MEASURE RELIABLY

  3 MAIN APPROACHES, EACH LIMITED

  1. EXPLICIT KNOWLEDGE PROBES
  2. IMPLICIT MEASURES
  3. SUBJECTIVE RATINGS
- R&D EFFORTS TEND TO BE FRACTIONATED

CONCLUSION: NEED FOR AN INTEGRATED ATTACK AT SEVERAL LEVELS (BASIC SCIENCE -- APPLICATION)

Table 1
Characteristics of Pilot Situation Awareness

Situation	Situation Components	Benefits of Awareness	Mission Categories	External Information Sources	Novice	Expert
Routine	Spatial orientation Environment Routine goals Procedures for attaining goals Aircraft system status Aircraft performance Crew responsibilities & knowledge	Mid-air collision avoidance Terrain avoidance Robust decision making in the face of: Turbulence Cross winds Windshear Loss of visibility	Local navigation, guidance and control Communication outside the cockpit Flight crew resource management Cabin management Routine management of physical equipment, resources, and systems Routine management of FMC and related crew aiding systems Bridging activities	Sensory information from the environment Cockpit visual and auditory displays Extra- and intra-aircraft communication Recorded flight plans Flight management computer Flight manuals and checklists Future 3D navigation aids	Expending unneccessary effort Not perceiving patterns	Utilizing non-competing resources Multiplexing Shortening transmissions Converting interference Chunking
Non-Routine	Special constraints Contingency plans	Improved decision making in the face of: Go around Weather rerouting	Macro-planning & navigation	Future route diversion aids	Making last minute plans during high workload	Shedding, delaying, and pre-loading tasks
Emergency	Unusual symptoms Trouble-shooting techniques Emergency procedures	Improved fault management	Diagnosis of physical equipment, resources, and systems Diagnosis of FMC & related crew-aiding systems	Future fault finding aids	Fixating on one or two salient possibilities Ignoring vital flight information while trouble-shooting	Letting go of high workload strategies

Note: The rows are cumulative. In other words, the entries for emergency situations include all the entries for routine and non-routine situations.

CURRENT PERSPECTIVES

AIR FORCE SYSTEMS COMMAND

THEORETICAL ISSUES

- 1 CONSTRUCT OR MANY? (SARTER & WOODS, OTHERS)
  - SPATIAL ORIENTATION
  - GEOGRAPHICAL SA
  - TACTICAL SA
    - IDENTITY (THREATS)
    - RESPONSIBILITY
    - TEMPORAL

THEORETICAL ISSUES (CONT.)

- PROCESS (ENDSLEY)
  - LEVEL I (PERCEPTION OF SIT ELEMENTS)
  - LEVEL II (INFORMATION INTEGRATION)
  - LEVEL III (PROJECTION OF FUTURE STATES)
- COGNITIVE UNDERPINNINGS? (FRACKER, BBN)
  - RELATION TO COGNITIVE MODELS, CONSTRUCTS
    - TOP-DOWN (KNOWLEDGE, RULE, SKILL DRIVEN)
    - BOTTOM-UP (DATA DRIVEN)
- INDIVIDUAL DIFFERENCES? TRAINABILITY?

MEASUREMENT ISSUES
(FRACKER, SARTER & WOODS)

- KINDS OF MEASURES
  - EXPLICIT (SELF-REPORT)--MEMORY, CONSCIOUS
    - REFLECTIVE
    - IMMEDIATE (SAGAT)
  - SUBJECTIVE (RATING)--DEFINED BY SCALES
  - IMPLICIT (INFERRED)--PERFORMANCE BASED
    - TSD (ENVELOPE SENSITIVITY)
    - EXPERT SYSTEMS (MODEL COMPARISON)
- QUALITY OF MEASURES (PSYCHOMETRIC)
  - FRACKER'S WORK

Tentative Conclusions

	RELIABILITY	VALIDITY: Content	VALIDITY: Criterion	VALIDITY: Construct
EXPLICIT				
Memory Probes	Variable	Limited	Moderate	Uncertain
IMPLICIT				
Sensitivity	Moderate	Limited	Unknown	Moderate
SUBJECTIVE				
HiRes	Uncertain	Limited	Poor	Uncertain

RESEARCH STRATEGIES

- MEASURE EXPLICITLY AS F OF SYSTEM MANIPULATION
  - NARROW FOCUS (STATIC, CONSCIOUS CONTENT)
- APPLY PRINCIPLES IN SELECTION, TRAINING ETC. AND MEASURE PERFORMANCE (IMPLICIT)
  - IS SA RESPONSIBLE?
- USE EXPERTS TO DEVELOP MODELS OF COMPLEX SCENARIOS (e.g. AIR COMBAT); TEST VS PERFORMANCE; REFINE.
  - SITUATION SPECIFIC?
- MULTIPLE MEASURES; CONVERGE ON CONSTRUCTS
  - PRIMARILY SUGGESTION

AF INITIATIVES

AIR FORCE SYSTEMS COMMAND

AL-WIDE CRASH PROGRAM (1 YEAR)

- "SAINT" TEAM FORMED
- WORKING DEFINITION

  "A PILOT'S CONTINUOUS PERCEPTION OF SELF AND A1C IN RELATION TO THE DYNAMIC ENVIRONMENT OF FLIGHT, THREATS, AND MISSION, AND THE ABILITY TO FORECAST, THEN EXECUTE TASKS BASED ON THE PERCEPTION"

- OBJECTIVES
  - DEVELOP <u>MEASURES</u> FOR VISUALLY-GUIDED AIR-AIR COMBAT
  - IDENTIFY PRELIM. <u>SELECTION</u> <u>TOOLS</u> (ASSUMES APTITUDE/ SKILL)
  - IDENTIFY PRELIM. <u>TRAINING</u> <u>TOOLS</u> (ASSUMES TRAINABLE SKILL)

3.1.1 Dr Grant McMillan (AL/CFHP). Serves as project leader and responsible for overall execution of the study.

3.1.2 Lt Col Jim Bushman (AL/CCE). Assists Dr McMillan in management and execution of the study.

3.1.3 Maj David Perry (AL/HRMAA). Responsible for development, test, and evaluation of the SAAB. Responsible for overall analyses of the study.

3.1.4 Dr Wayne Waag (AL/HRAT). Responsible for development, test, and evaluation of the SA Rating Scale. Assists in overall study analyses.

3.1.5 Dr Mike Vidulich (AL/CFHP). Responsible for identification of the cognitive and performance components of SA. Advises on the development of the SAAB and the SA Rating Scale.

3.1.6 Dr Sam Schiflett (AL/CFTO). Advises on the development of the SAAB and SA Rating Scale.

3.1.7 Maj Glen Larsen (USAFSAM/FP). Consultant to overall study.

3.1.8 Lt Col Tim Kinney (WL/FIP). Joint Cockpit Office representative. Serves as consultant to overall study.

RESEARCH PLAN

- CONCURRENT DEVELOPMENT OF
  - THEORY-DRIVEN (COGNITIVE) SA APTITUDE TEST BATTERY
  - EXPERT-DRIVEN (BEHAVIORAL) CRITERION--BARS
- VALIDATION IN AIR-COMBAT SIMULATOR USING SELECTED SCENARIOS AND PILOTS

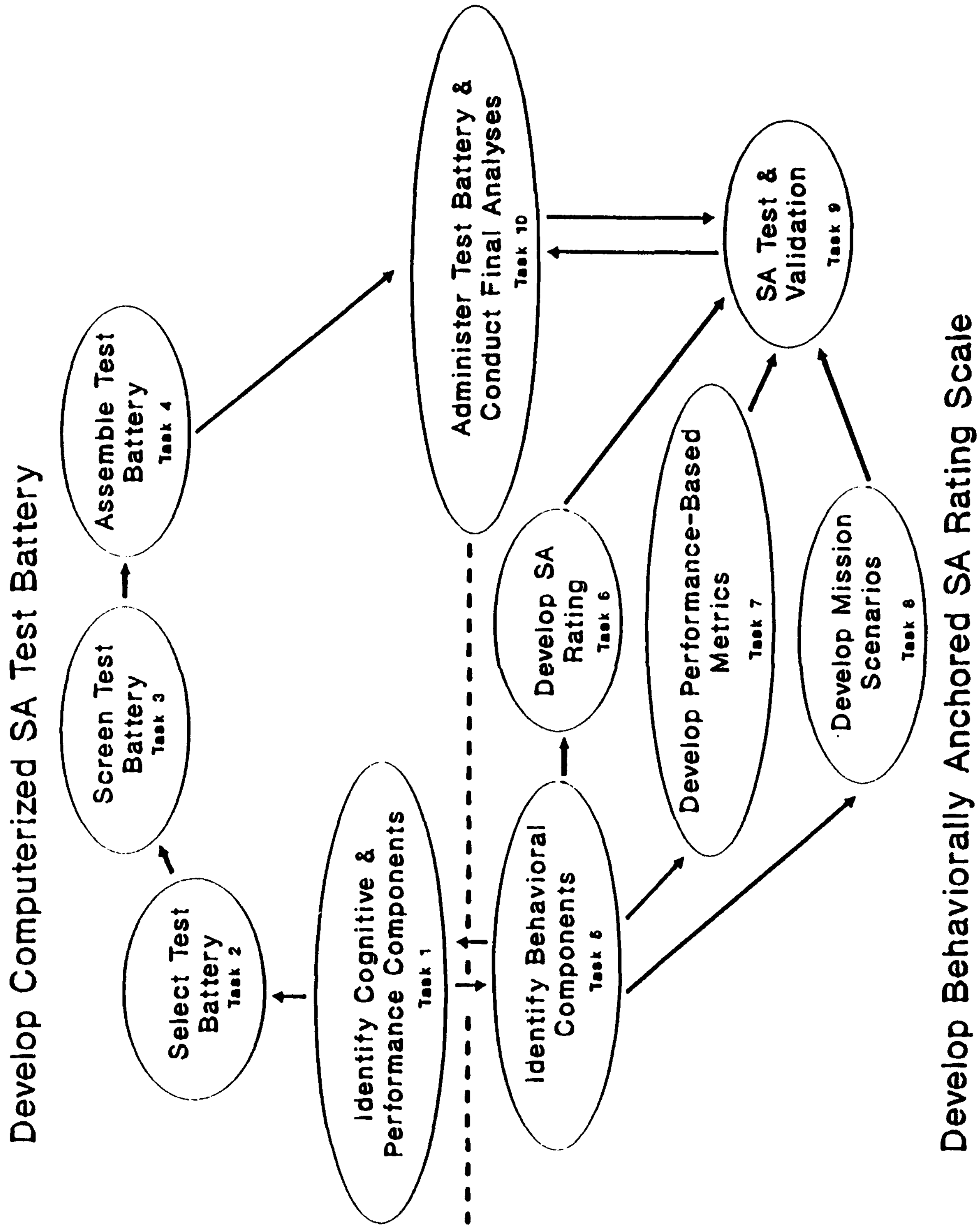

Figure 1. SAINT Research Plan

AFOSR 6.1 TEAM SA INITIATIVE

- EXPLORE GROUP PROCESSES IN TEAM PERFORMANCE
  - SHARED AND INDIVIDUAL SA
  - HOW DO YOU PROMOTE?
    - COMMUNICATION ISSUES
    - "GROUPWARE" ISSUES
    - GROUP STRUCTURE/PROCESS ISSUES
    - LEADERSHIP, TRAINING ISSUES

DR. MICHAEL DRILLINGS

U.S. Army Basic Research Office
5001 Eisenhower Ave, Alexandria, VA

REPORTS OF THE COMMITTEE ON TECHNIQUES FOR THE ENHANCEMENT OF HUMAN PERFORMANCE

U.S. Army Research Institute
Basic Research Office

Michael Drillings
(703) 274-5572; DSN 284-5572

ENHANCING HUMAN PERFORMANCE

- **Commissioned by the Army Research Institute**

- **Performed by the National Research Council**

- **Major Reports of Phases I & II are:**

Druckman, D. & Swets, J. A., eds. 1988. <u>Enhancing Human Performance: Issues, Theories, and Techniques</u>. Washington: National Academy Press.

Druckman, D. & Bjork, R. A., eds. 1991. <u>In the Mind's Eye: Enhancing Human Performance</u>. Washington: National Academy Press.

ENHANCING HUMAN PERFORMANCE

PHASE I OBJECTIVES:

- **Evaluate Selected, Non-Mainstream Techniques**
- **Provide an Authoritative Assessment of These Techniques for Policymakers in R&D**
- **Consider the Use of the Techniques in Army Training**
- **Develop Appropriate Criteria for Evaluating Claims**
- **Recommend Research to Better Understand Performance Enhancement**

U.S. Army Research Institute/March 92

ENHANCING HUMAN PERFORMANCE

"EVALUATING HUMAN TECHNOLOGIES...."
HEGGE, TYNER, AND GENSER (1983)

- **Effects of Technique**
- **Evidence for Claims**
- **Theoretical Support**
- **Who will be able to use**
- **Implications for Army Operations**
- **Army Philosophy**
- **Cost — Benefit Factors**

ENHANCING HUMAN PERFORMANCE

Learning During Sleep

- No Evidence During Verified Sleep
- May be Some Effects During Light Sleep
- May be Relevant to State-Dependent Learning and Retention
- May be Cost-Effective for Additive Training
- Deserves More Research

ENHANCING HUMAN PERFORMANCE

Accelerated Learning

- Systems Approach is Warranted
- No evidence of "Non-Mainstream" effects
- Greater Application Possible in Army

Mental Practice

- Is Effective, But Not in Place of Physical Practice
- Attentional Control & Visual Concentration Training not Proven
- Sybervision™ Not Proven
- Biofeedback Not Proven

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ENHANCING HUMAN PERFORMANCE

Altering Mental States

- No Evidence for Hemispheric Effects on Performance
- No Evidence for Hemi-Sync^{tm}
- Is There an Optimal Level of Arousal?
- Hypnosis and Meditation Should be Investigated
- No Validated Measures of Hemisphericity

U.S. Army Research Institute/March 92

ENHANCING HUMAN PERFORMANCE

Stress Management

- Relaxation Training — Effective
- Biofeedback — Limited Utility
- Cognitive Restructuring — Effective
- Behavioral Skills Training — Effective
- Relevance to Military Situation
- Societal Issues

ENHANCING HUMAN PERFORMANCE

Influence Strategies

- No Evidence for Effect of Neurolinguistic Programming
- Social Psych Literature Could be Basis for Techniques for Training to Influence Soldiers

Group Cohesion

- Lack of Studies Linking Cohesion & Performance
- There may be some Negative Effects

U.S. Army Research Institute/March 92

ENHANCING HUMAN PERFORMANCE

Parapsychology

- Evidence does not Justify Optimism
- Remote Viewing and Ganzeld Experiments are Flawed
- Psychokinesis Effects are Extremely Small and the Research is also Flawed
- Recommends a Common Protocol for Experimentation

U.S. Army Research Institute/March 92

ENHANCING HUMAN PERFORMANCE

PHASE II OBJECTIVES:

- **Address Broad Theoretical Principles Underlying Training Program**
- **More Basic Issues of Performance**

U.S. Army Research Institute/March 92

ENHANCING HUMAN PERFORMANCE

Long-Term Retention & Transfer

- **Maximum Performance at End of Training May be Sub-Optimal for Long-Term Performance**
- **Increased Retention:**
  - **Increased Original Learning, Varying Learning Conditions, Develop Automaticity, Build in Environmental Cues, Mnemonics, Elaboration, Distributing Practice, Cooperative Learning, Doing, Testing, Part-Task Training**
- **Increased Transfer:**
  - **Contextual Interference During Training, Variety in Training, Reducing Feedback**

U.S. Army Research Institute/March 92

ENHANCING HUMAN PERFORMANCE

Modeling Expertise

- **Is the Expert-Modeling Component the Most Critical?**
- **Problem for Modeler**
- **Problem for Learner**
- **Role of Explanation**
- **Role of Domain Knowledge**
- **Unproven, Except for Basic Skills**

ENHANCING HUMAN PERFORMANCE

Developing Careers

Myers-Briggs Type Indicator:

- **Unsuited for Self-Assessment**
  - **Reliability**
  - **Construct Validity**
  - **Predicting Validity**
  - **Discrimination Between Occupations**

ENHANCING HUMAN PERFORMANCE

Subliminal Self-Help

- No Evidence that it is Effective
- No Reason to Believe That it could be

Meditation

- No "Special" Effect
- Epistemological Note
- Other Evidence

ENHANCING HUMAN PERFORMANCE

Optimizing Individual Performance

- **Relaxation, Imagery, Mental Preparation Strategies, Skill Development Strategies, and Coping Produce Small to Moderate Improvements in Motor Performance in Less than Elite Performers.**

- **Preperformance Routines Seem to be Effective.**

- **Aerobic Exercise Helps People to Cope Better with Psychosocial Stressors.**

- **Neuropsychological Advances are Promising.**

ENHANCING HUMAN PERFORMANCE

Team Performance

- Research on Group Structure and Functions is Lacking
- Groups Should be Stratified for Military Relevance
- Difficult to Generalize Results from Real Groups
- What is Optimal Division of Training Between Team and Individual Skills?

ENHANCING HUMAN PERFORMANCE

PHASE III OBJECTIVE:

- **Look More at Army Training Environment**

Candidate Topics:

- **Hypnotic Augmentation of Performance**
- **Situated Learning**
- **Motivation**
- **Sensory Transformation**

MR. DENIS BREGLIA

Naval Training Systems Center, Code 251
Orlando, Florida

VIRTUAL ENVIRONMENT TRAINING TECHNOLOGY

VETT

Denis R. Breglia
Simulation Imagery Branch
Naval Training Systems Center

VE TECHNOLOGY

A communication medium which facilitates natural, high efficiency interaction between a user and a computer generated environment

VE FEATURES

Efficient

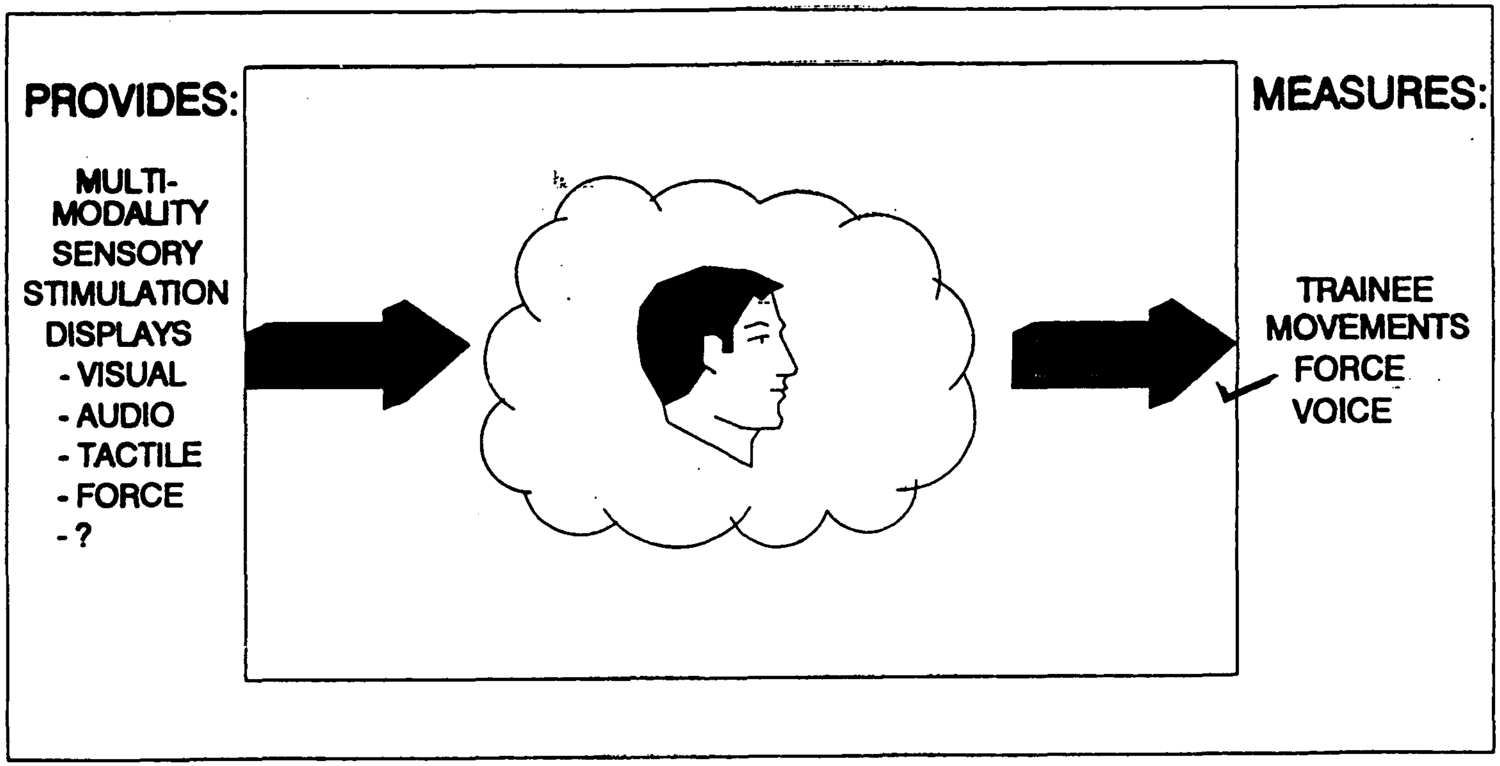
Flexible

Multimodal

Three-dimensional

Interactive

VIRTUAL ENVIRONMENT



VE APPLICATIONS

COMMUNICATION	TELEOPERATION
EDUCATION	RECREATION
DESIGN	VISUALIZATION
PROGRAMMING	DECORATING
SHOPPING	ENTERTAINMENT
MEDICAL	

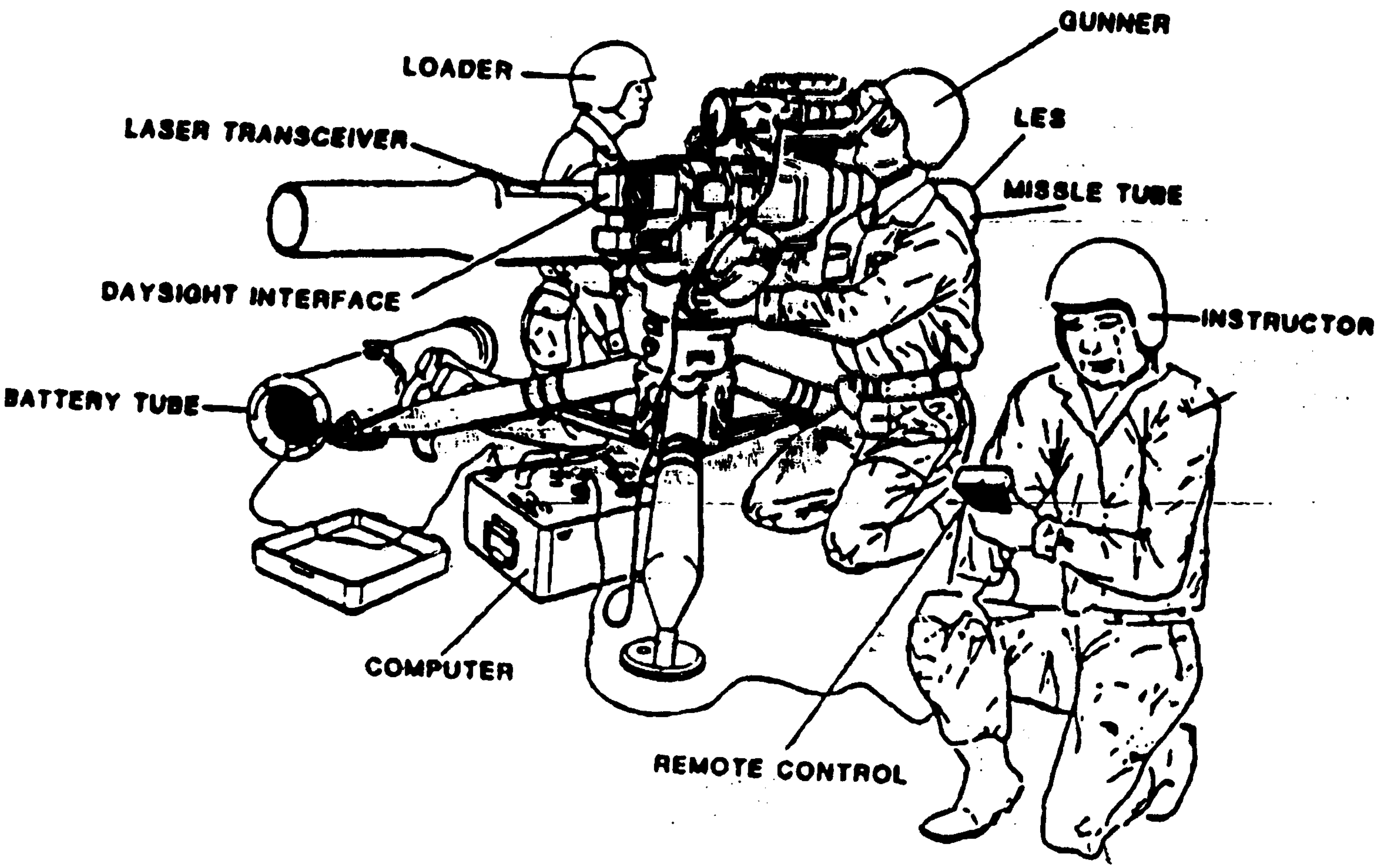
& TRAINING !

CHALLENGES FACING MILITARY TRAINING

* DECREASING ECONOMIC RESOURCES
* INCREASING COMPLEXITY OF TASKS
* INCREASING COSTS OF INSTRUCTIONAL PERSONNEL
* DECREASING AVAILABILITY OF RANGES
* INCREASING UTILIZATION OF RESERVES
* INCREASING COSTS OF TRAINING TDY
* DECREASING AVAILABILITY OF SCHOOLHOUSES
* INCREASING NEED FOR TEAM TRAINING
* CHANGING ROLE OF MILITARY

NTSC 251 1100 03/92

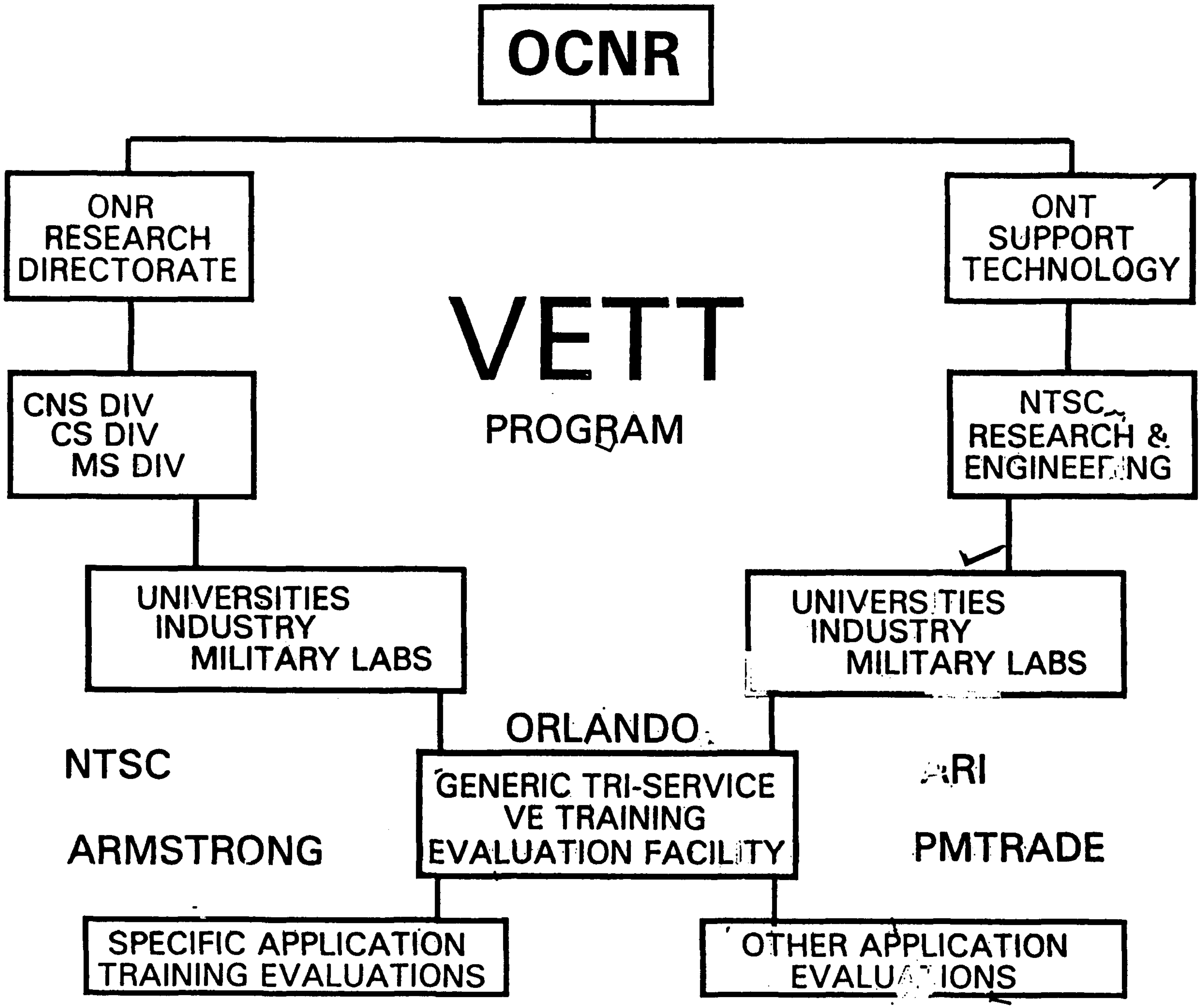
Anti-Tank Weapon Precision Gunnery Training System (PGTS)



VETT

POTENTIAL PAYOFFS

- DECREASED TRAINER DEVELOPMENT & AND ACQUISITION COSTS
- DECREASED TRAINER OPERATION & AND MAINTENANCE COSTS
- REDUCED PHYSICAL REQUIREMENTS: WEIGHT, SIZE, ENERGY
- DEPLOYABLE, AVAILABLE
- ENHANCED TRAINING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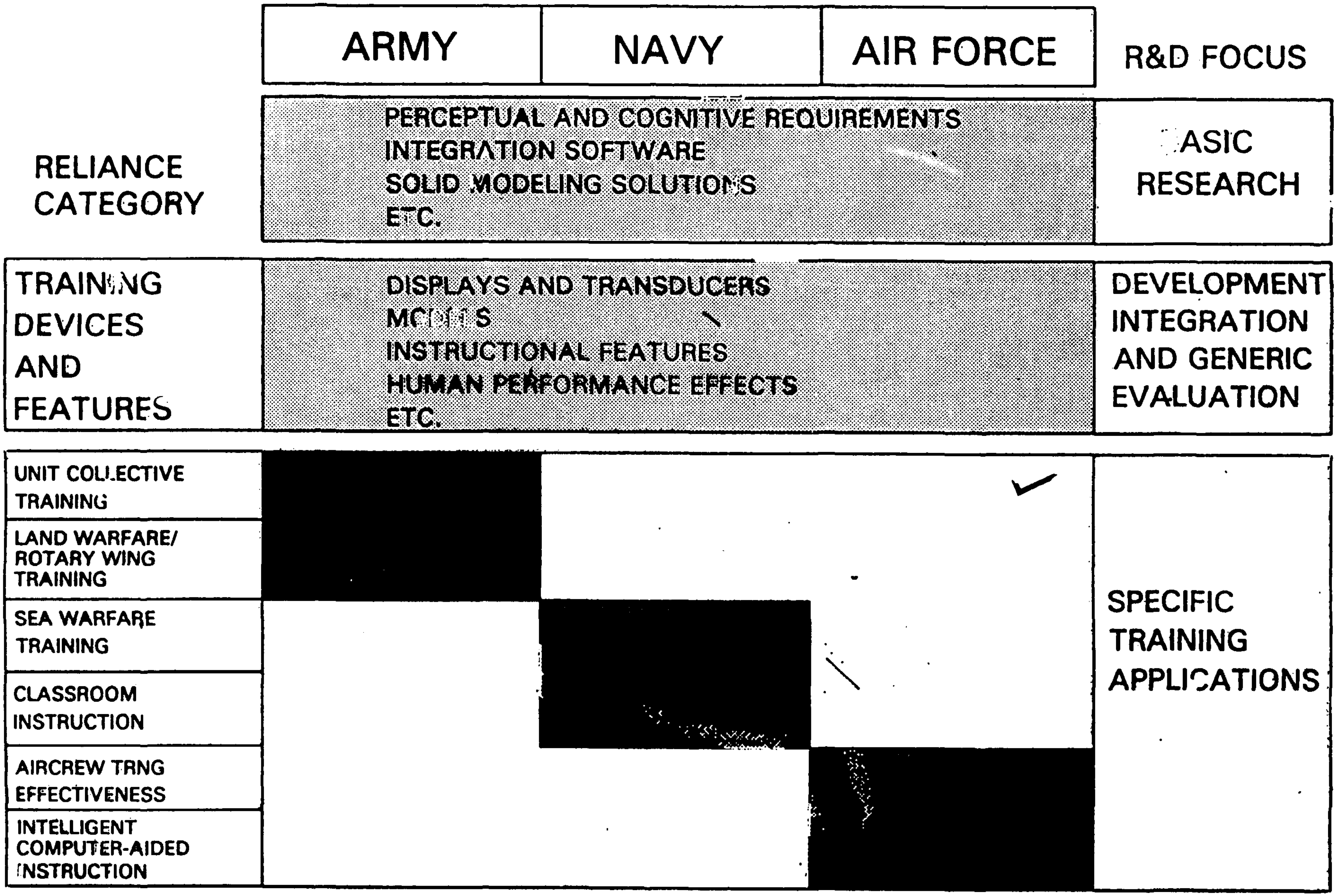
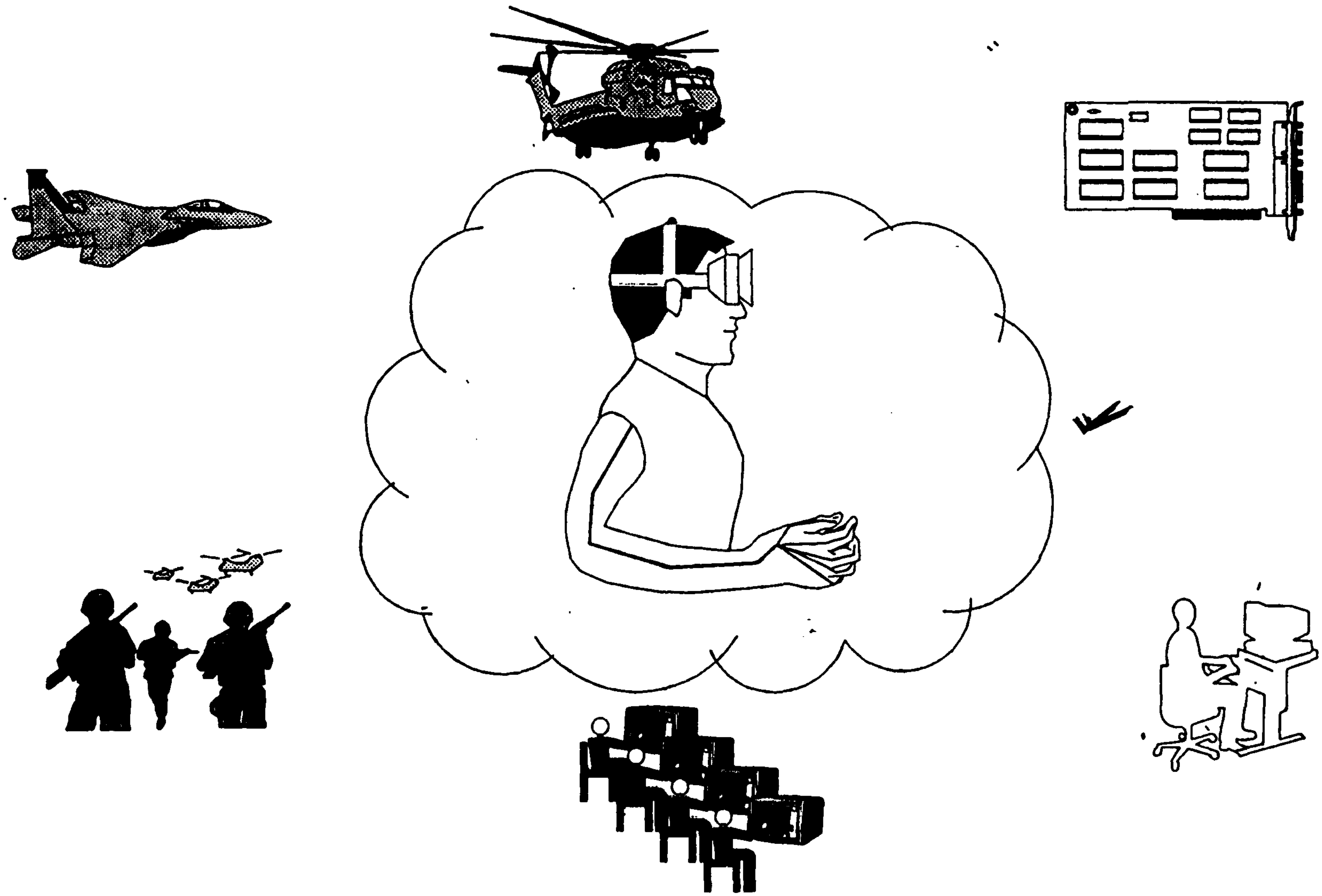
ORLANDO
GENERIC TRI-SERVICE VE TRAINING EVALUATION FACILITY
NTSC
ARMSTRONG
ARI
PMTRADE
SPECIFIC APPLICATION TRAINING EVALUATIONS
OTHER APPLICATION EVALUATIONS

RELIANCE STRUCTURE FOR VETT



VIRTUAL ENVIRONMENT TRAINING



SIMULATOR VS VE

TRAINING SIMULATOR

HMI SPECIFIC TO EQUIPMENT BEING SIMULATED - 1000'S OF DESIGNS

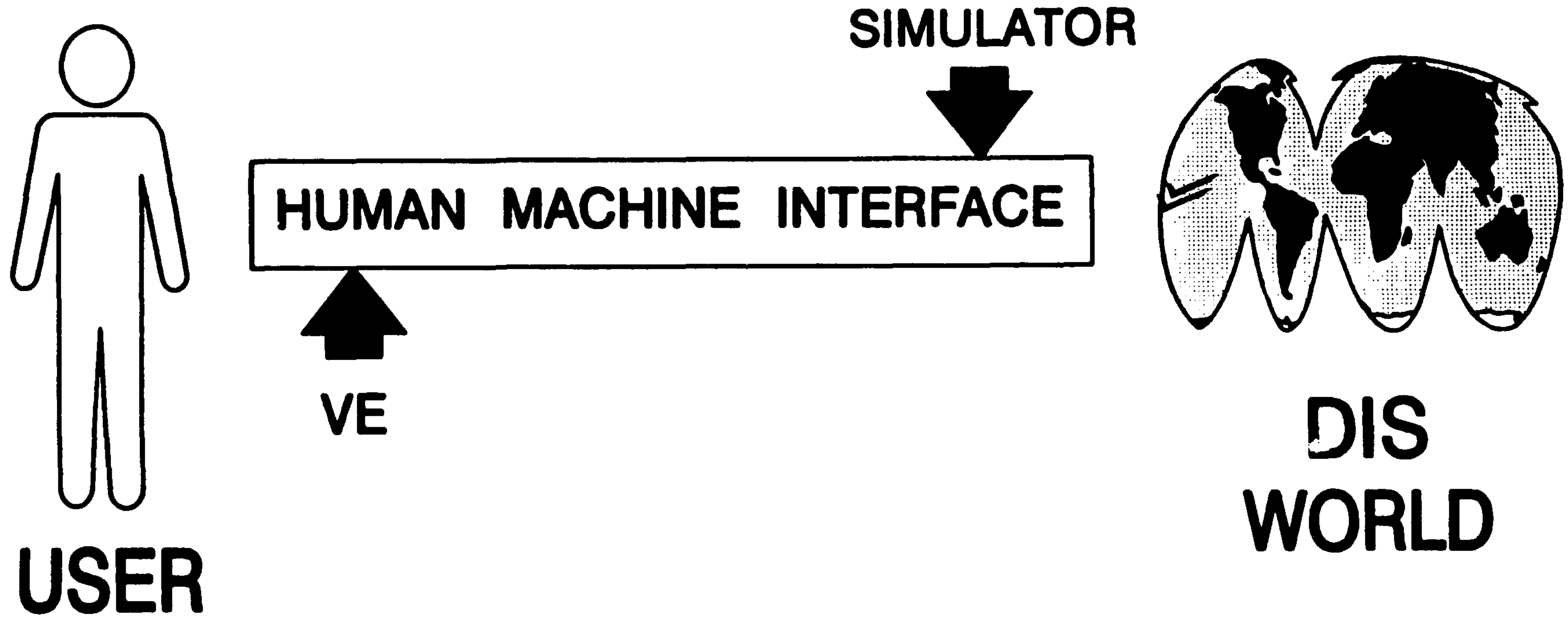
ENVIRONMENT MODELED TO REAL WORLD PHYSICS

VE TRAINING

ONE OR FEW HMI HARDWARE DESIGNS

ENVIRONMENT DESIGNED FOR LEARNING

VE TRAINING
VS
SIMULATOR TRAINING



NTSC 251 1101 03/92

VETT PROJECT

OBJECTIVE: Improve affordability and effectiveness of training through application of VE.

APPROACH: Develop, demonstrate, and evaluate VE-based training system concepts.

NTSC 251 t102 03/92

VE TRAINING APPLICATIONS

CONCEPT APPLIES TO ALL TRAINING

BUT

NOW LIMITED BY TECHNOLOGY SOA

VETT APPROACH

3 PARALLEL EFFORTS

DEVELOP COMPONENT TECHNOLOGIES

DESIGN AND INTEGRATE CANDIDATE TRAINING APPLICATIONS

EVALUATE POTENTIAL COST AND TRAINING EFFECTIVENESS

VE DISPLAYS

VISUAL, AUDITORY & HAPTIC

AND, EVENTUALLY

VESTIBULAR, OLFACTORY & GUSTATORY

VISUAL DISPLAYS

ISSUES

AFFORDABILITY	FULL COLOR
FIELD OF VIEW	COMFORT
RESOLUTION	CONVENIENCE

NTSC 251 1003 03/92

AUDITORY DISPLAYS

ISSUES

3-D CALIBRATION

EFFECTIVE UTILIZATION

NTSC 251 1104 03/92

HAPTIC DISPLAYS

ISSUES

GROUNDED FORCES

TACTILE ICONS

WHOLE BODY ACCELERATION

NTSC 251 1105 03/92

VE TRANSDUCERS

POSITION

ORIENTATION

FORCE

SPEECH

POSITION AND ORIENTATION TRANSDUCERS

ISSUES

FREEDOM OF MOVEMENT

ABSOLUTE/RELATIVE

INTERFERENCE

NTSC 251 1106 03/92

FORCE TRANSDUCERS

ISSUES

INTIMATE WITH FORCE DISPLAY

REACTIVE AND PROACTIVE

NTSC 251 1107 03/92

SPEECH TRANSDUCERS

ISSUES

SPEAKER INDEPENDENT

CONTEXT INDEPENDENT

CONTINUOUS SPEECH

NT[illegible].1103 03/92

TRAINING ENVIRONMENTS

ISSUES

Multimodal cue substitution and/or enhancement

Departures from the physics of the real world

Visualization of the invisible

Behavior of virtual actors

BEHAVIORAL RESEARCH ISSUES

* PERFORMANCE EFFECTIVENESS	- CAN THE JOB BE DONE IN A VE
* TRAINING EFFECTIVENESS	- IS VETT THE BEST WAY TO TRAIN
* SIDE EFFECTS	- DISORIENTATION, VERTIGO, ETC.
* EFFECT OF IMMERSION	- IS IMMERSION CRITICAL TO TRAINING

VETT COMPLEXITY LEVELS

1. SEATED OPERATOR, CONSOLE, 3-D VISUALIZATION

2. PLATFORM OPERATOR, WORKBENCH

3. SEATED TEAM, NETWORK

4. AREA OPERATOR

5. AREA TEAM

SEATED OPERATOR

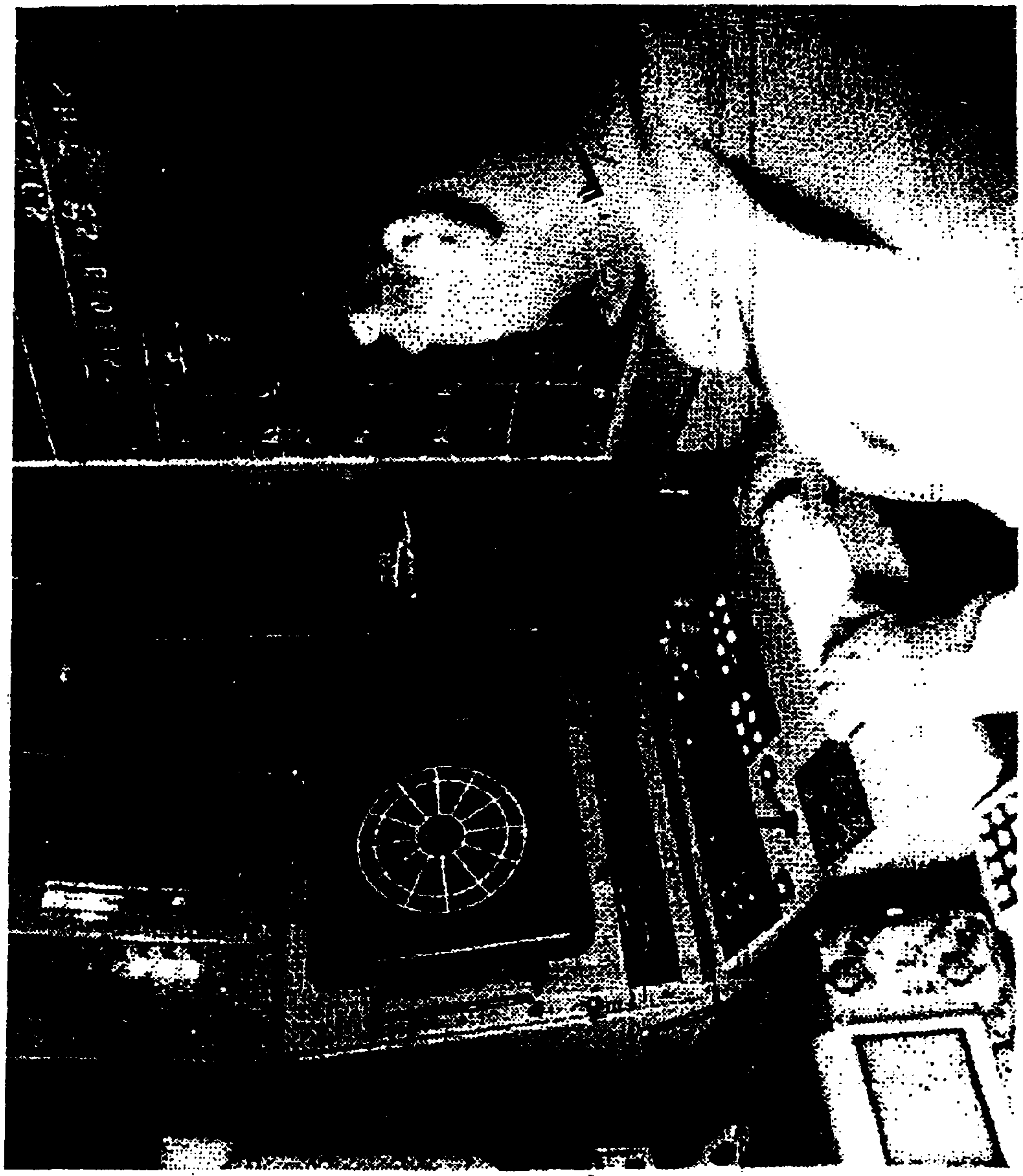
VE - 1 MONITOR, BUTTONS, SWITCHES, KNOBS, INSTRUMENT DISPLAYS, KEYBOARD, AUDIO

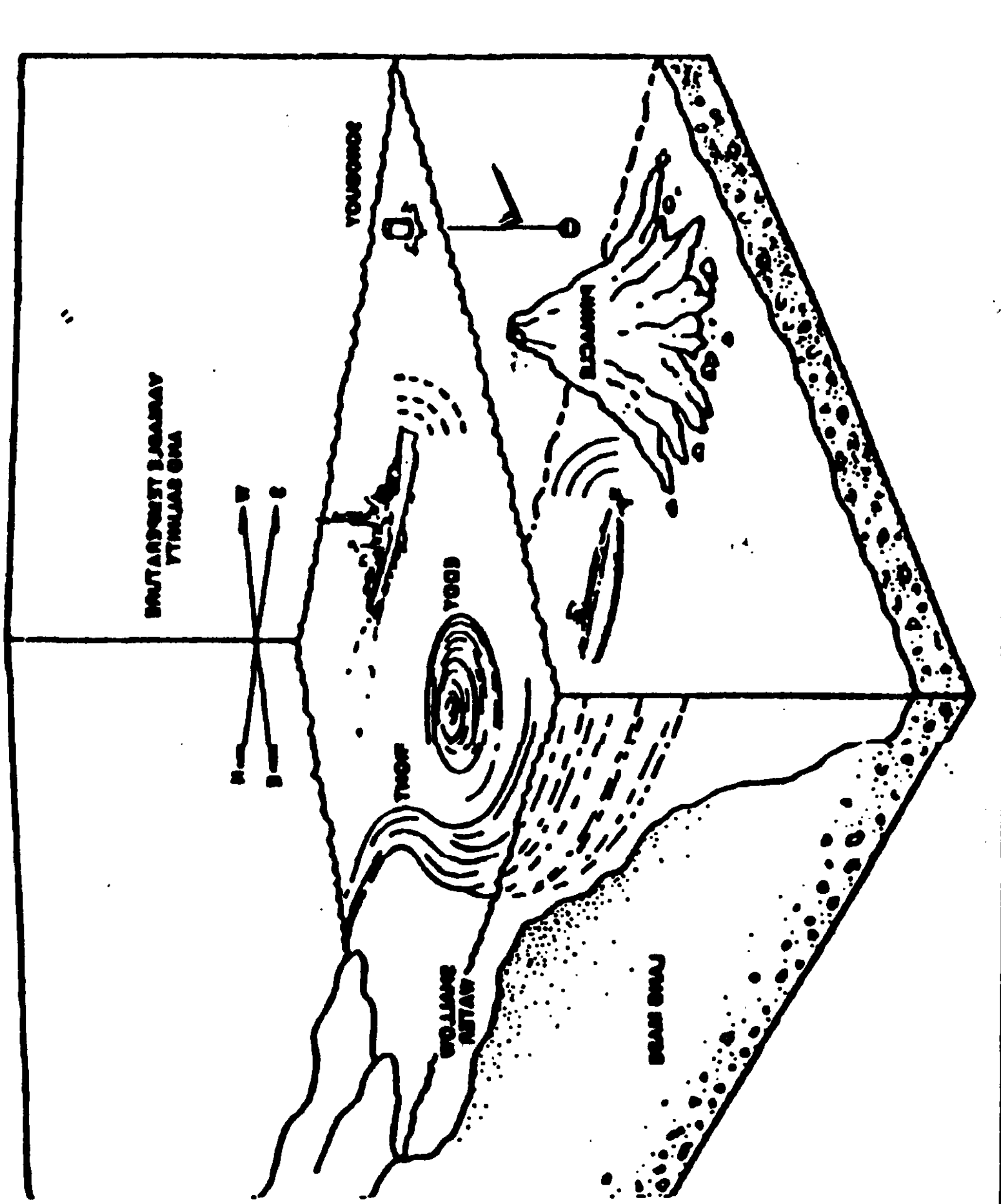
VE - 2 WRAP AROUND, DYNAMIC, 3-D

VE HARDWARE

DISPLAYS - HMD, HEADPHONES, GLOVES

TRANSDUCERS - HEAD, HAND, FINGER P & O





PLATFORM OPERATOR

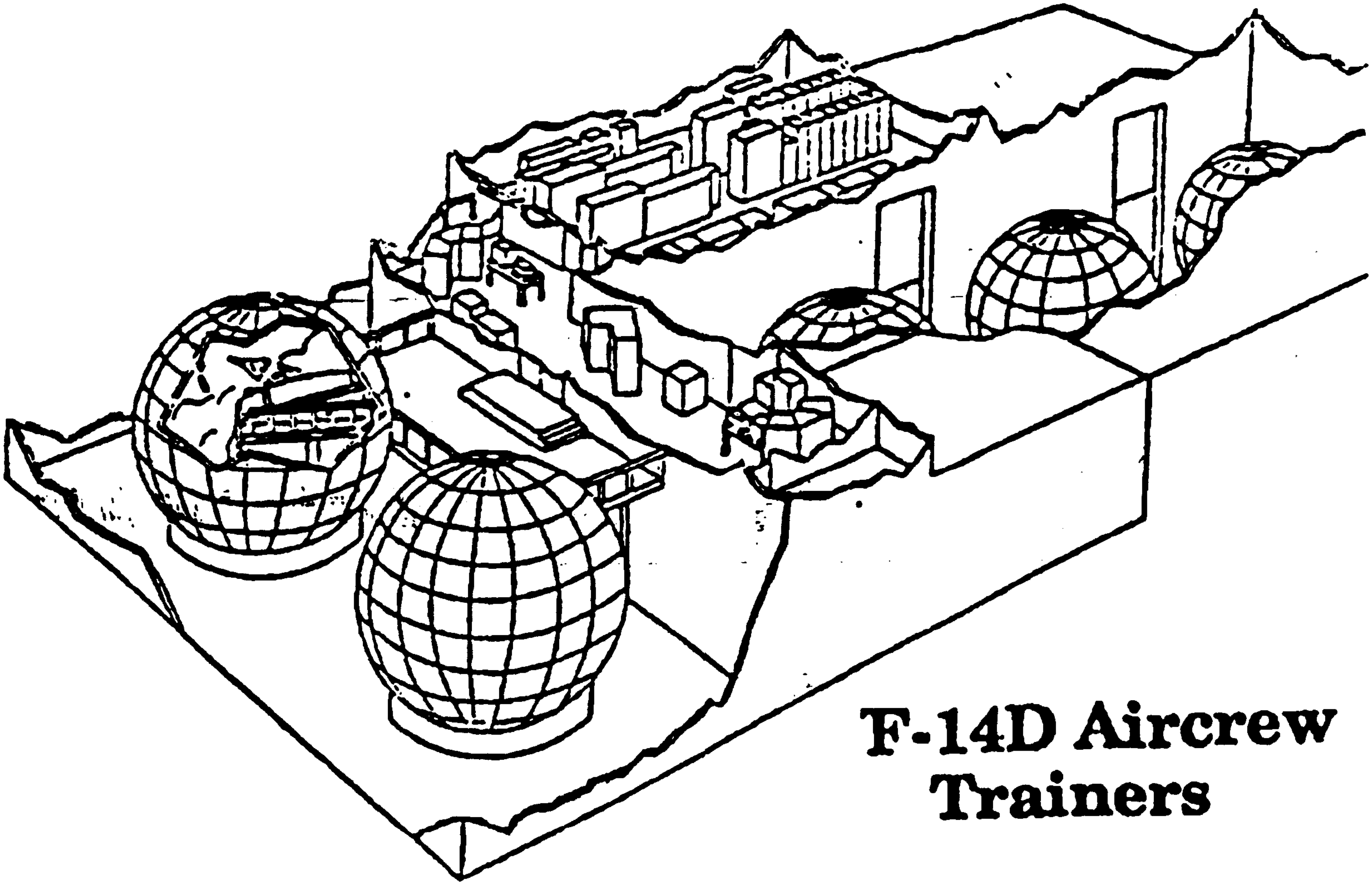
VE - 1 MANUAL CONTROLS AND DISPLAYS, AUDIO, FORCES

VE - 2 WORKBENCH, HANDTOOLS

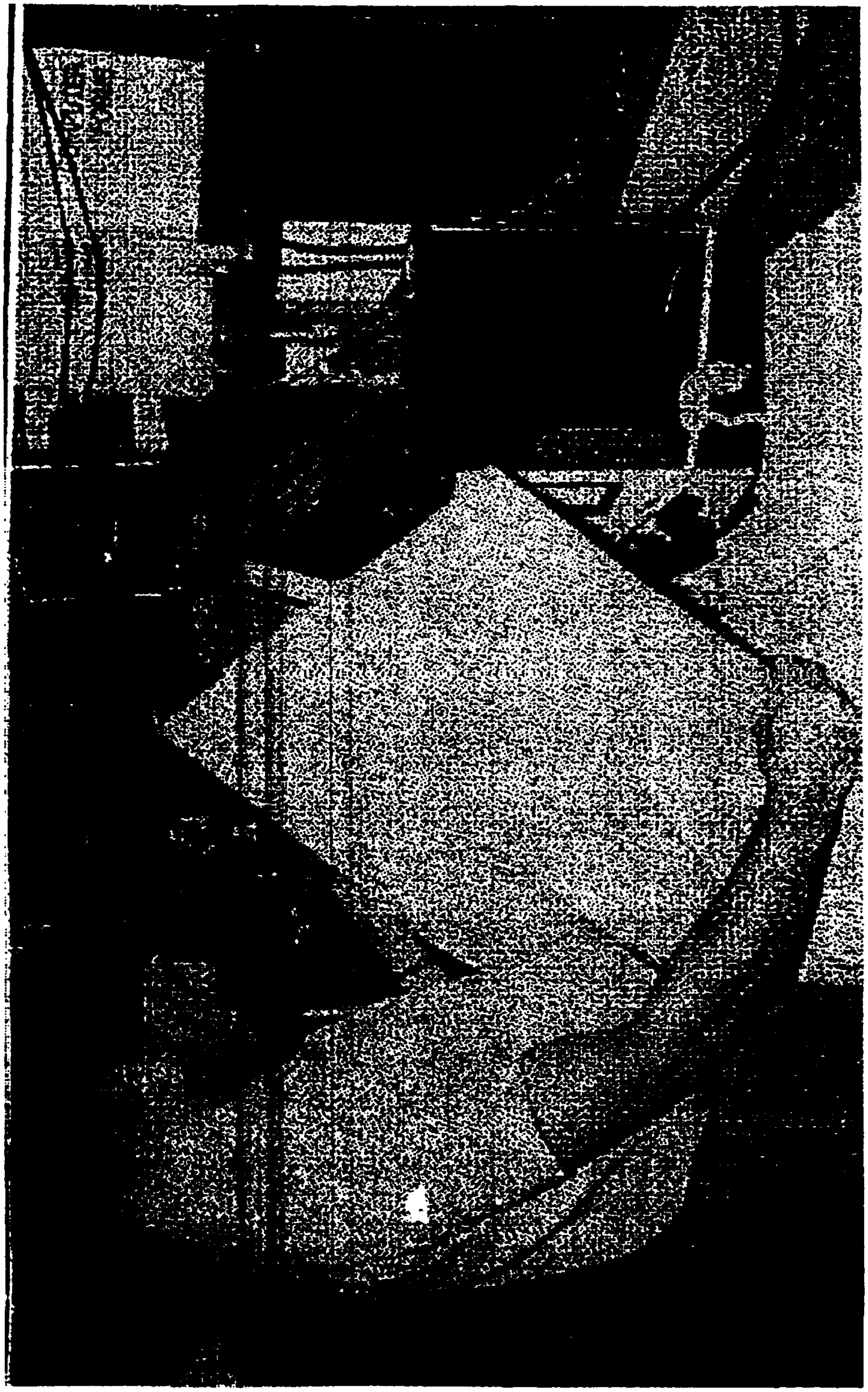
VE HARDWARE

DISPLAYS - LEVEL 1 PLUS FORCE

TRANSDUCERS - LEVEL 1 PLUS FORCE



F-14D Aircrew Trainers



SEATED TEAM

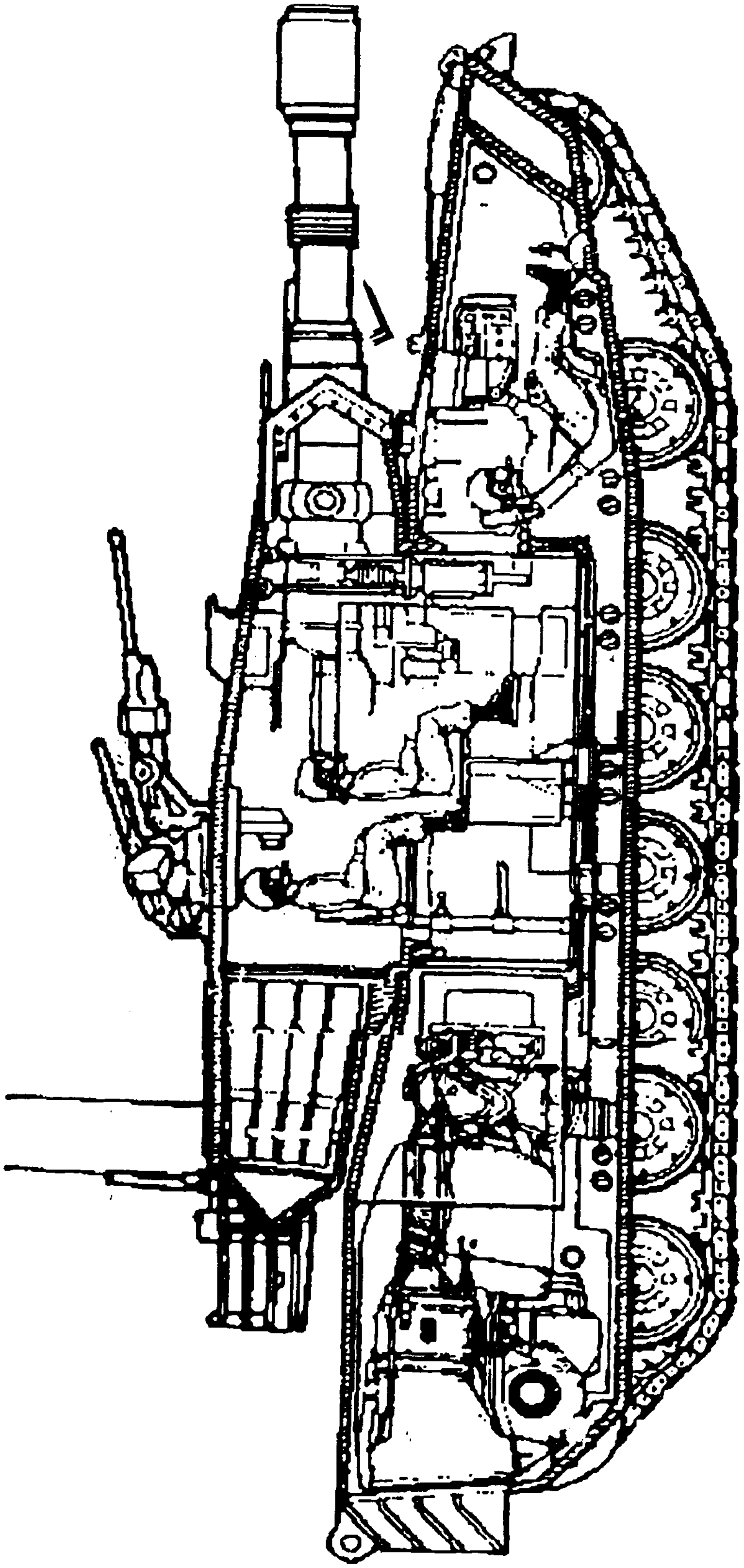
VE - 1 AUDIBLE TEAM / INSTRUCTOR

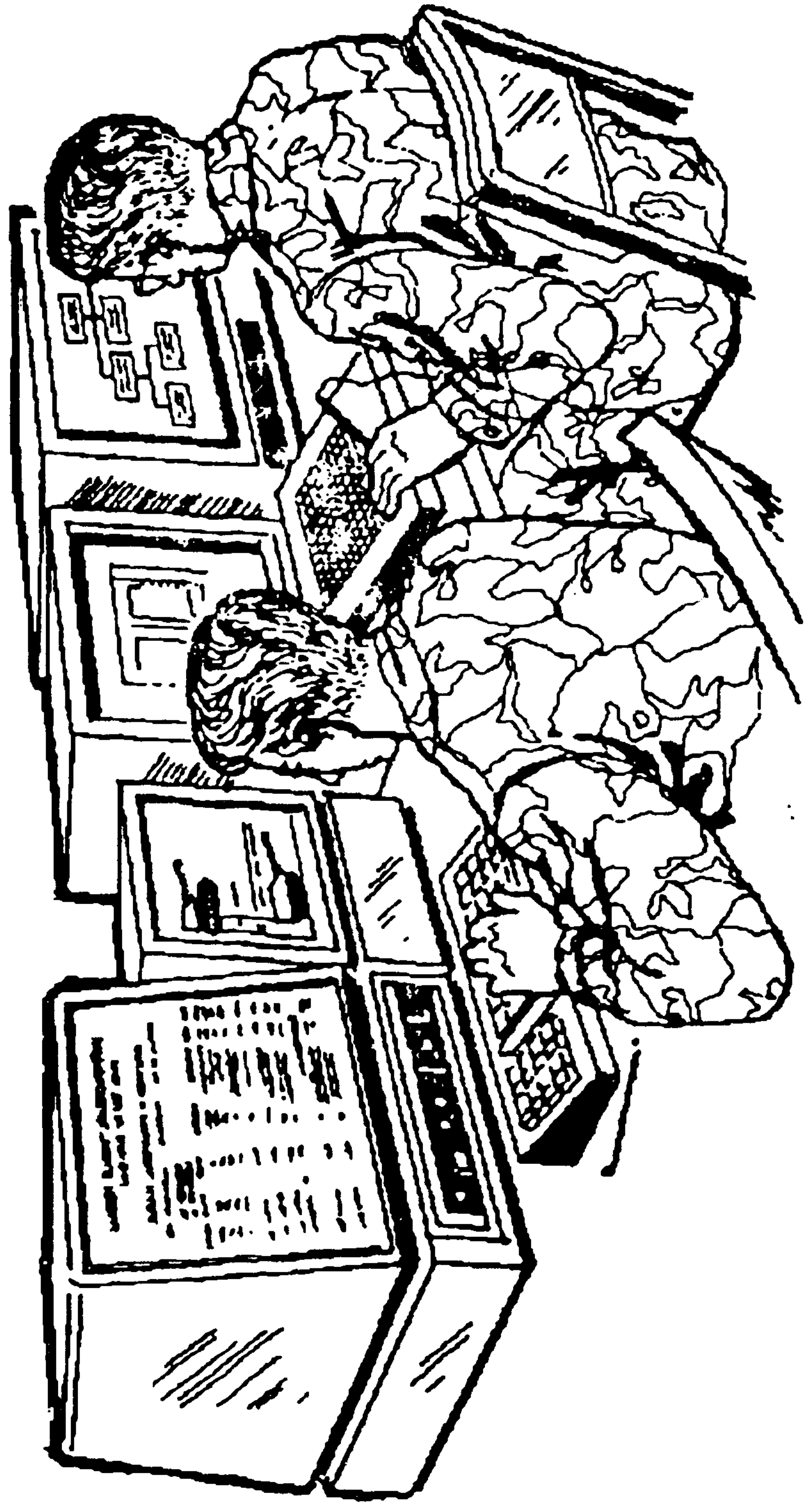
VE - 2 VISIBLE TEAM / INSTRUCTOR

VE HARDWARE

DISPLAYS - LEVEL 2 PLUS PEOPLE

TRANSDUCERS - LEVEL 2 PLUS SPEECH





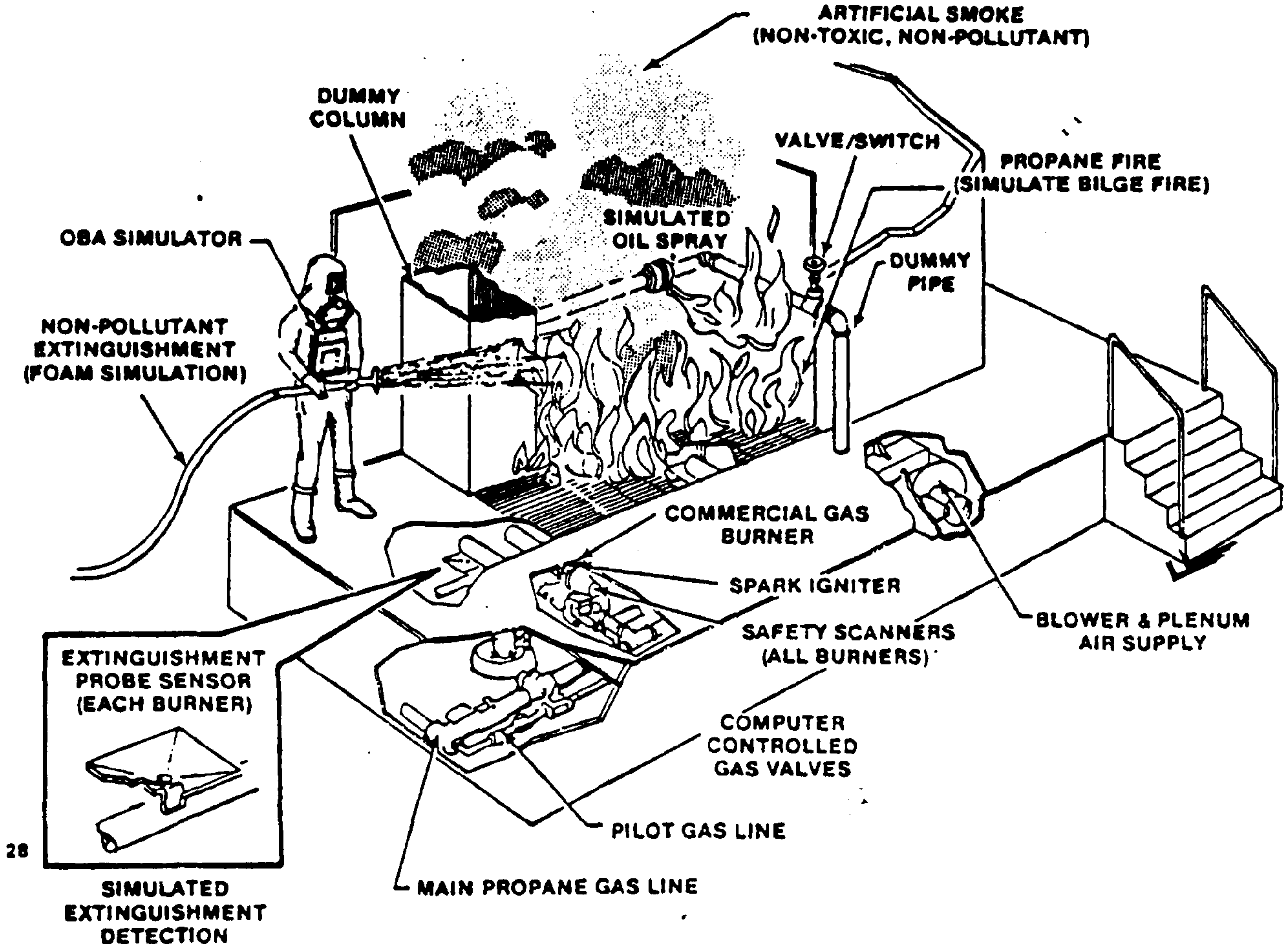
AREA OPERATOR

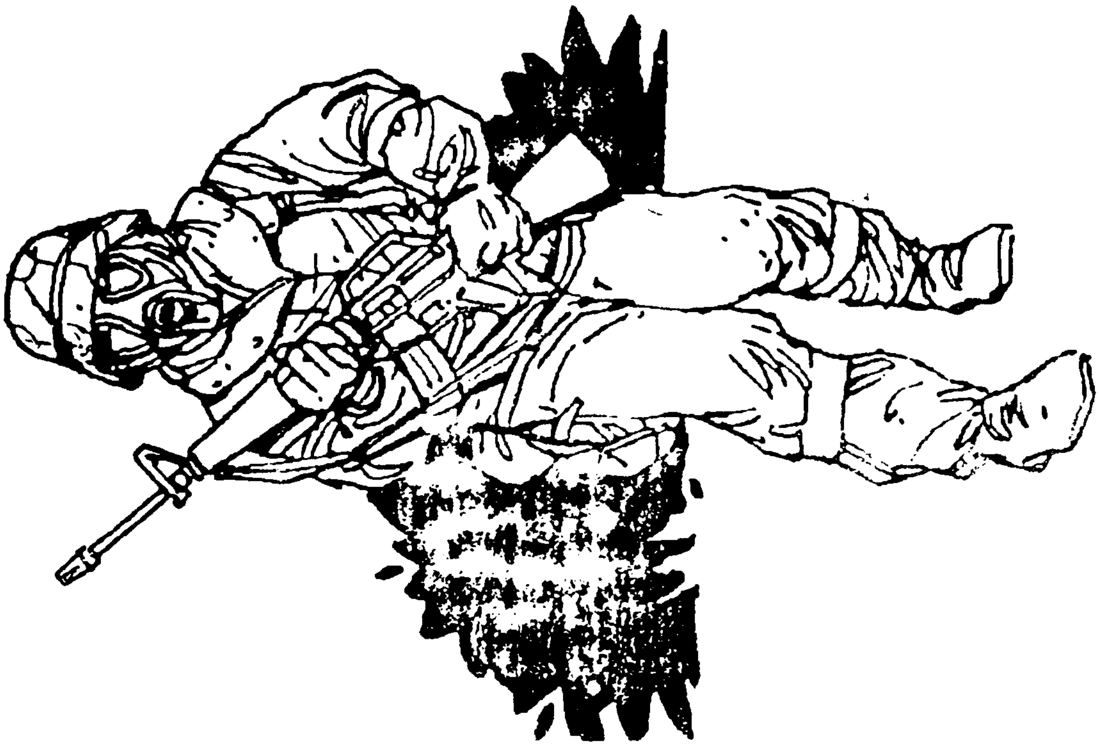
VE — STAND, WALK, BEND

VE HARDWARE

DISPLAYS - LEVEL 3 PLUS GROUNDED FORCE

TRANSDUCERS - LEVEL 3 PLUS WHOLE BODY P & O & FORCE


ARTIFICIAL SMOKE
(NON-TOXIC, NON-POLLUTANT)
DUMMY
COLUMN
VALVE/SWITCH
PROPANE FIRE
(SIMULATE BILGE FIRE)
SIMULATED
OIL SPRAY
OBA SIMULATOR
DUMMY
PIPE
NON-POLLUTANT
EXTINGUISHMENT
(FOAM SIMULATION)
COMMERCIAL GAS
BURNER
SPARK IGNITER
SAFETY SCANNERS
(ALL BURNERS)
BLOWER & PLENUM
AIR SUPPLY
EXTINGUISHMENT
PROBE SENSOR
(EACH BURNER)
COMPUTER
CONTROLLED
GAS VALVES
PILOT GAS LINE
28
SIMULATED
EXTINGUISHMENT
DETECTION
MAIN PROPANE GAS LINE



AREA TEAM

VE MULTI - PERSONNEL MANUAL TASKS

VE HARDWARE

DISPLAYS - LEVEL 4 PLUS PEOPLE

TRANSDUCERS - LEVEL 4

SUBGROUP SESSION I

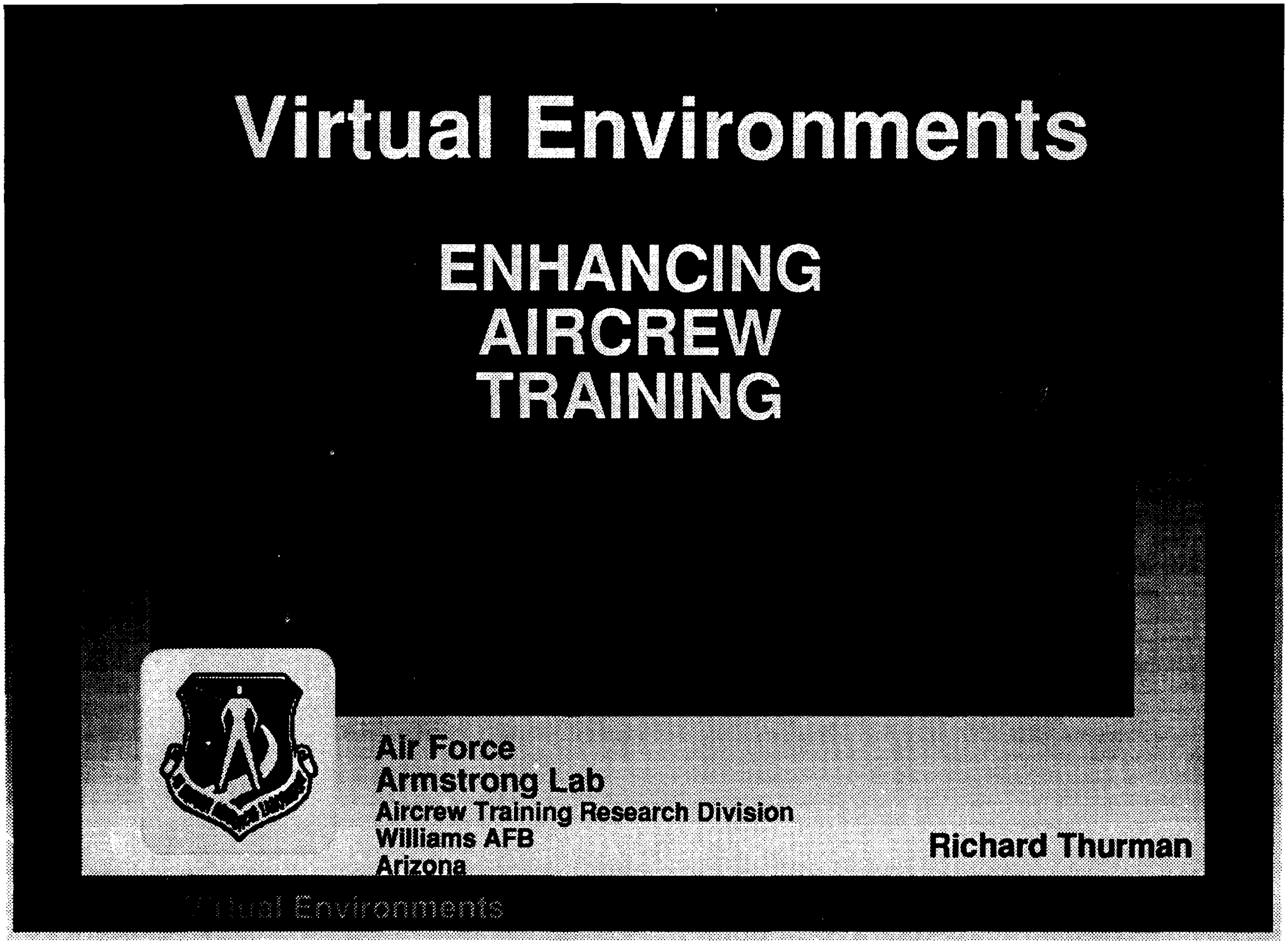
ADVANCED TRAINING TECHNOLOGY

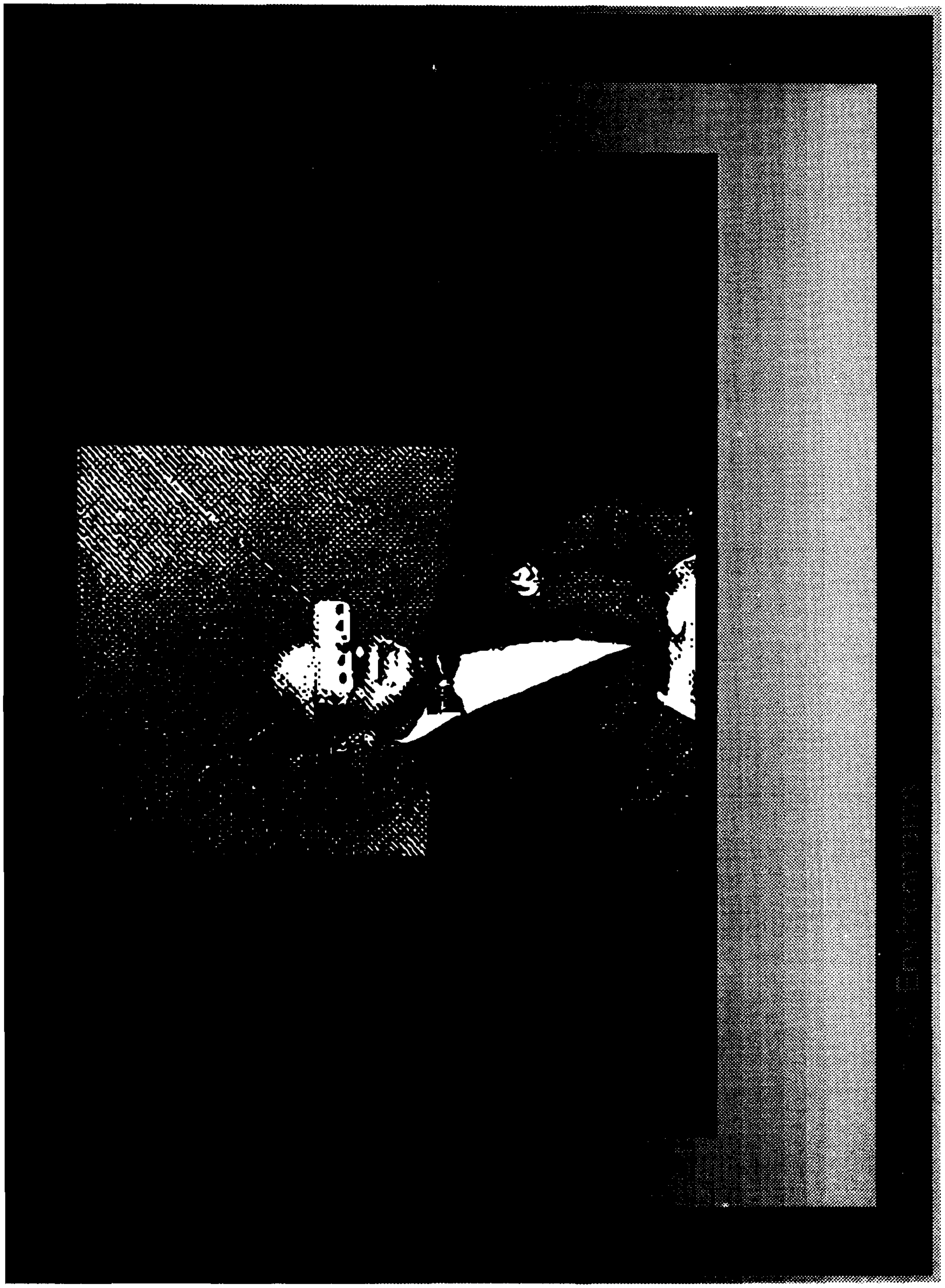
Introduction and Administrative Issues Subgroup Theme:
Simulator, Simulations and "Virtual Reality"

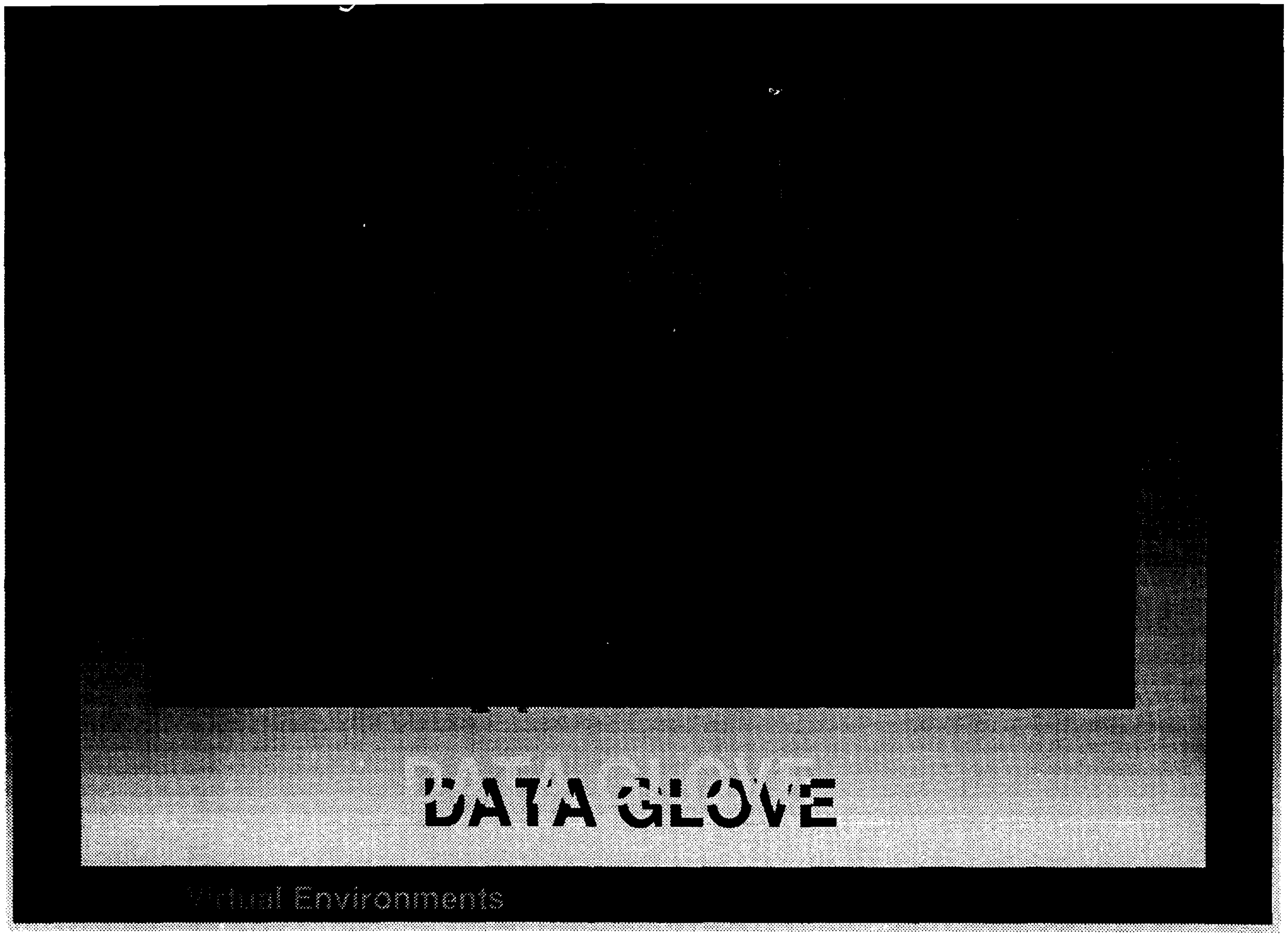
Enhancing Aircrew Training Through Virtual
Environment Research:
Dr. Richard Thurman

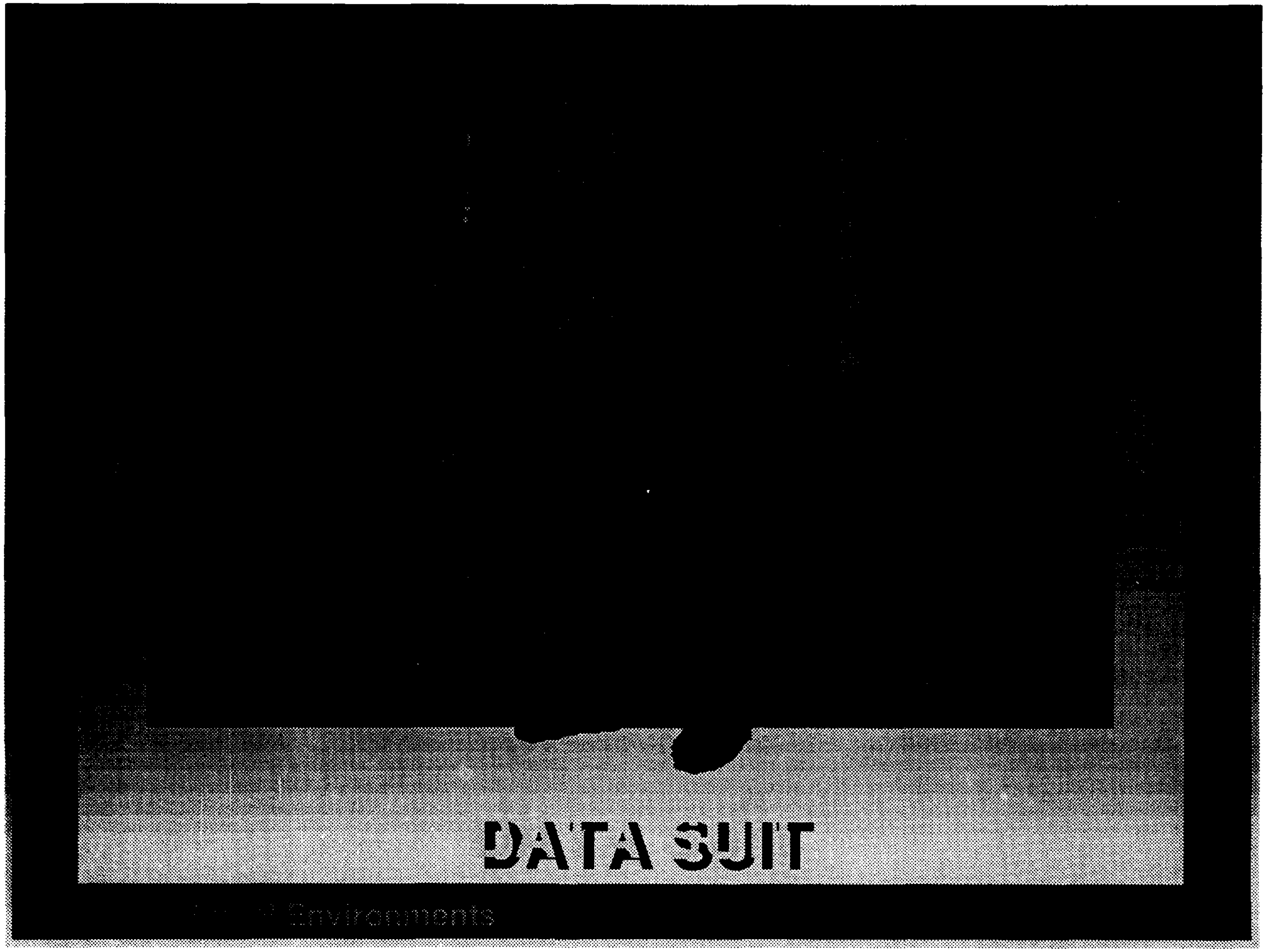
Research on the Use of Virtual Environment in
Crisis Management in the Navy:
Ms. Janet Dickieson
(no hard copies available)

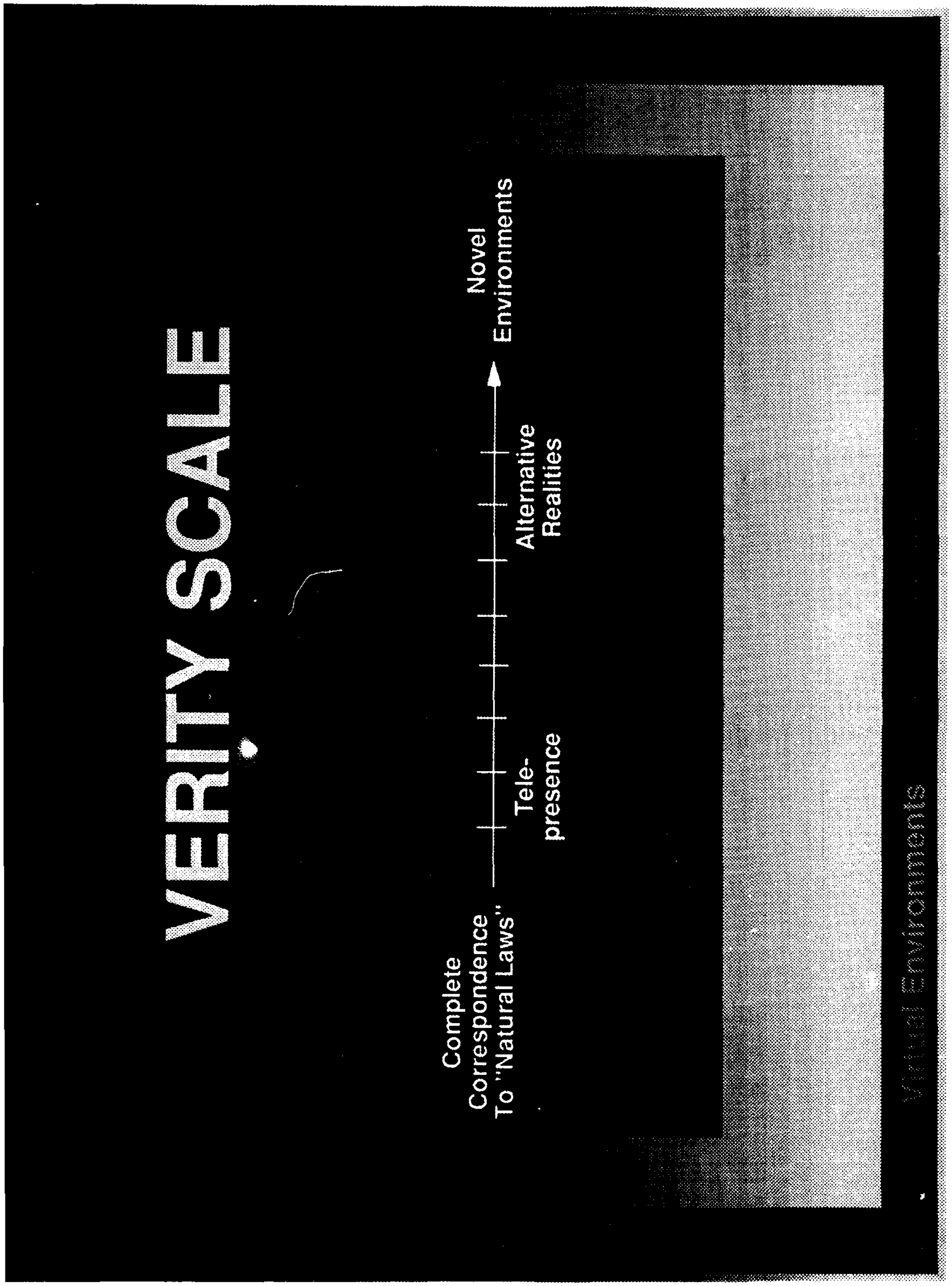
Behavioral Requirements for Training
in Virtual Environments:
Dr. Bruce Knerr

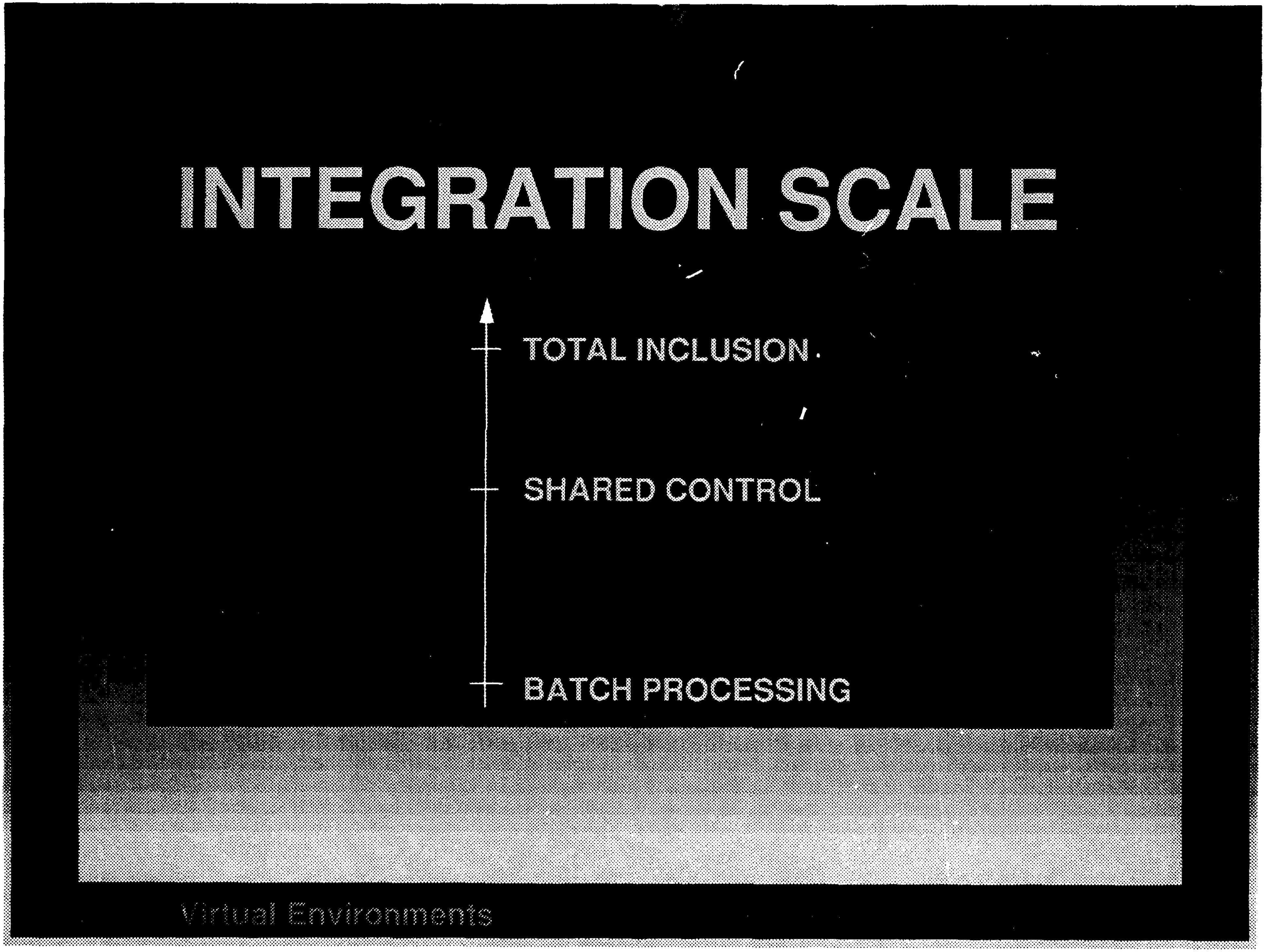

Virtual Environments
ENHANCING
AIRCREW
TRAINING
Air Force
Armstrong Lab
Aircrew Training Research Division
Williams AFB
Arizona
Richard Thurman
Virtual Environments

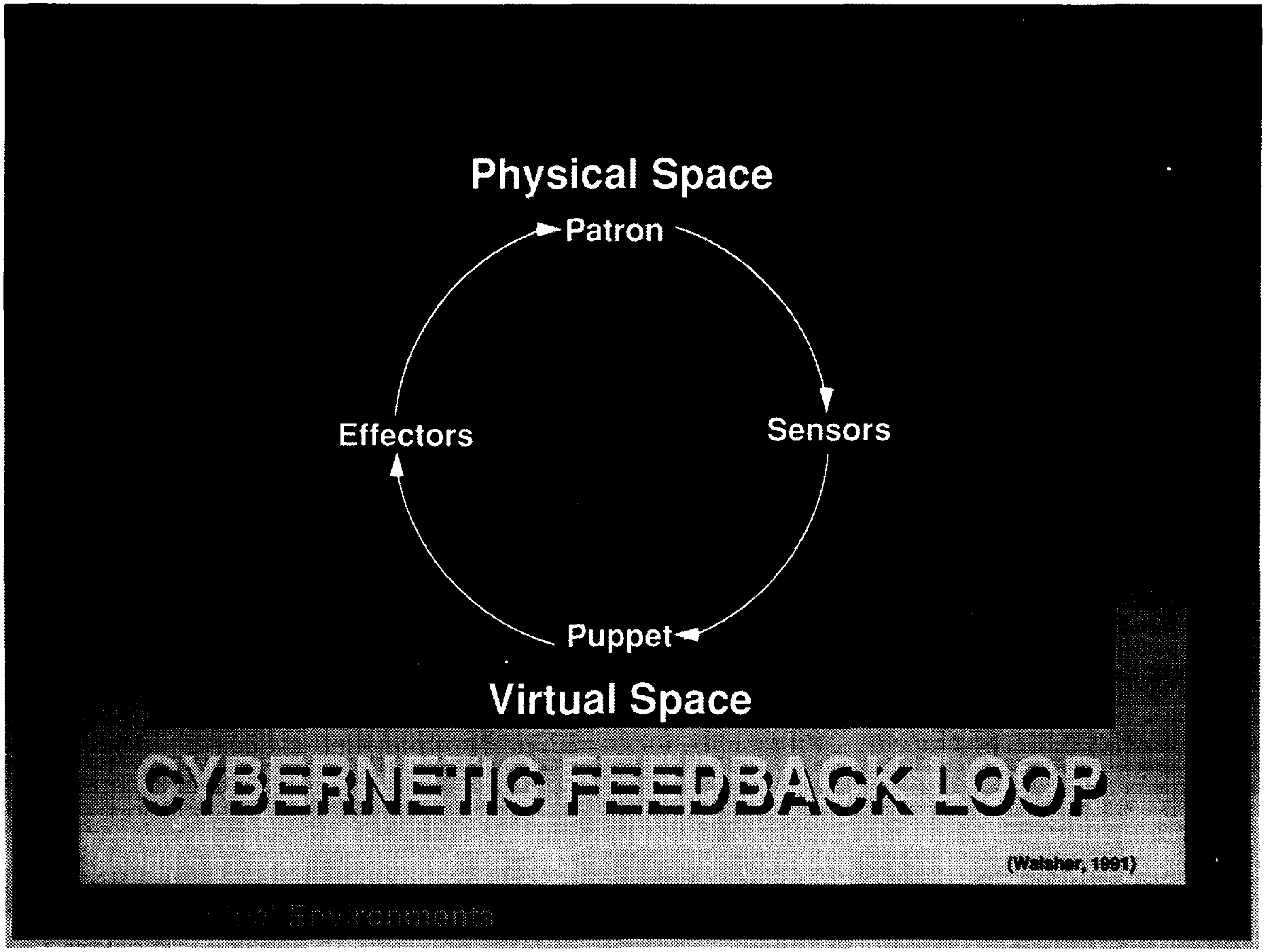


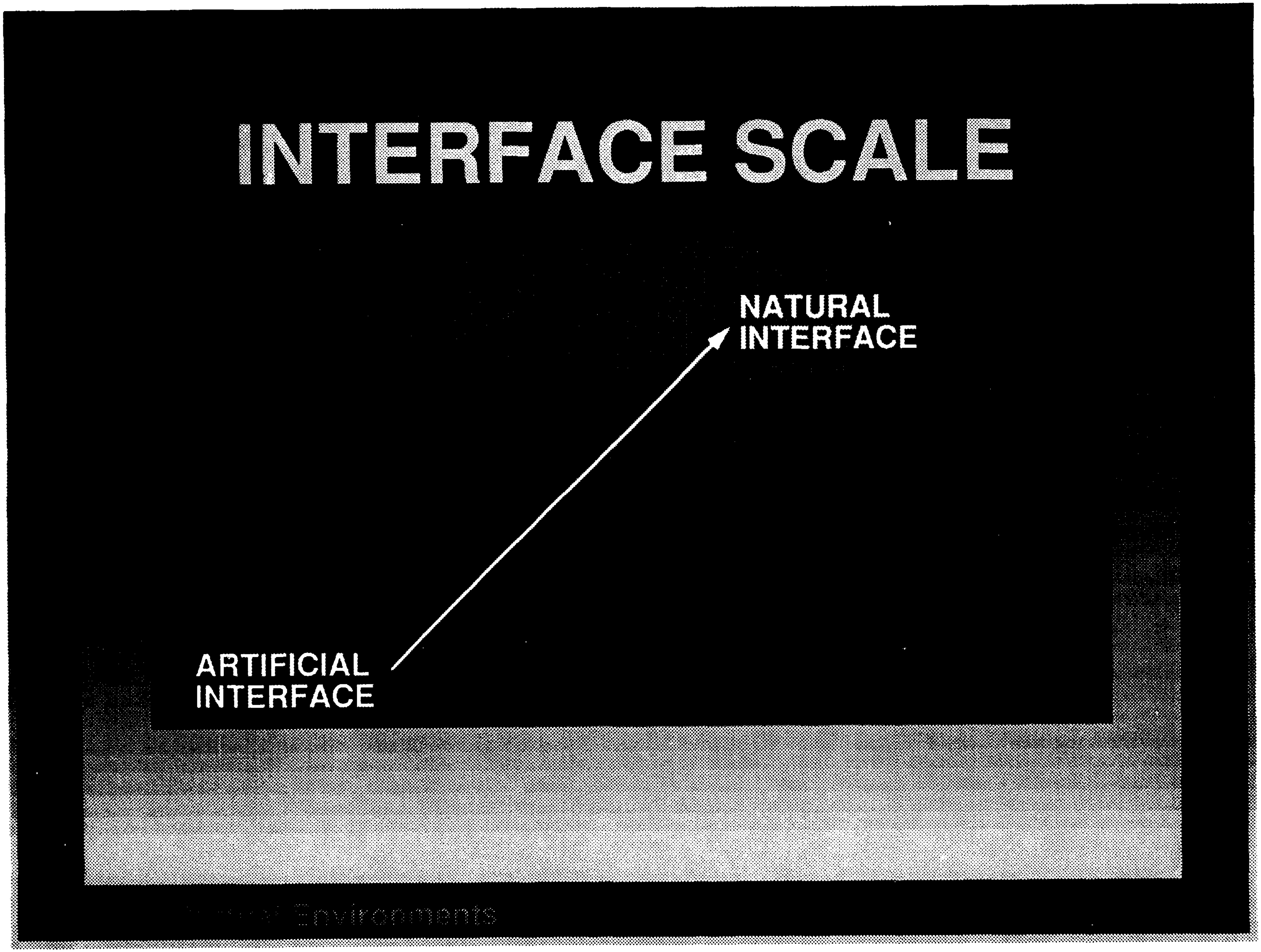

DATA GLOVE
Virtual Environments

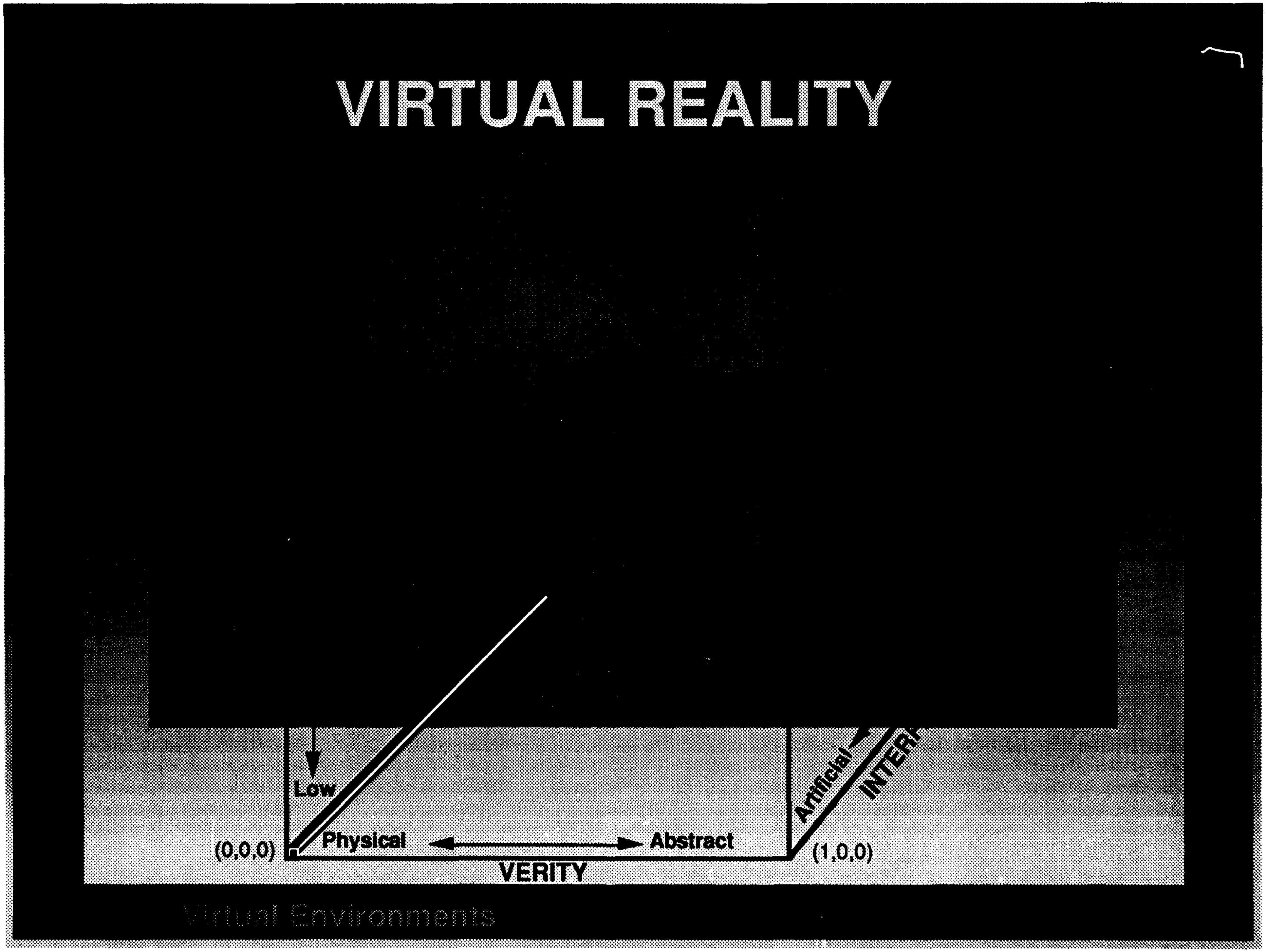

DATA SUIT
Environments

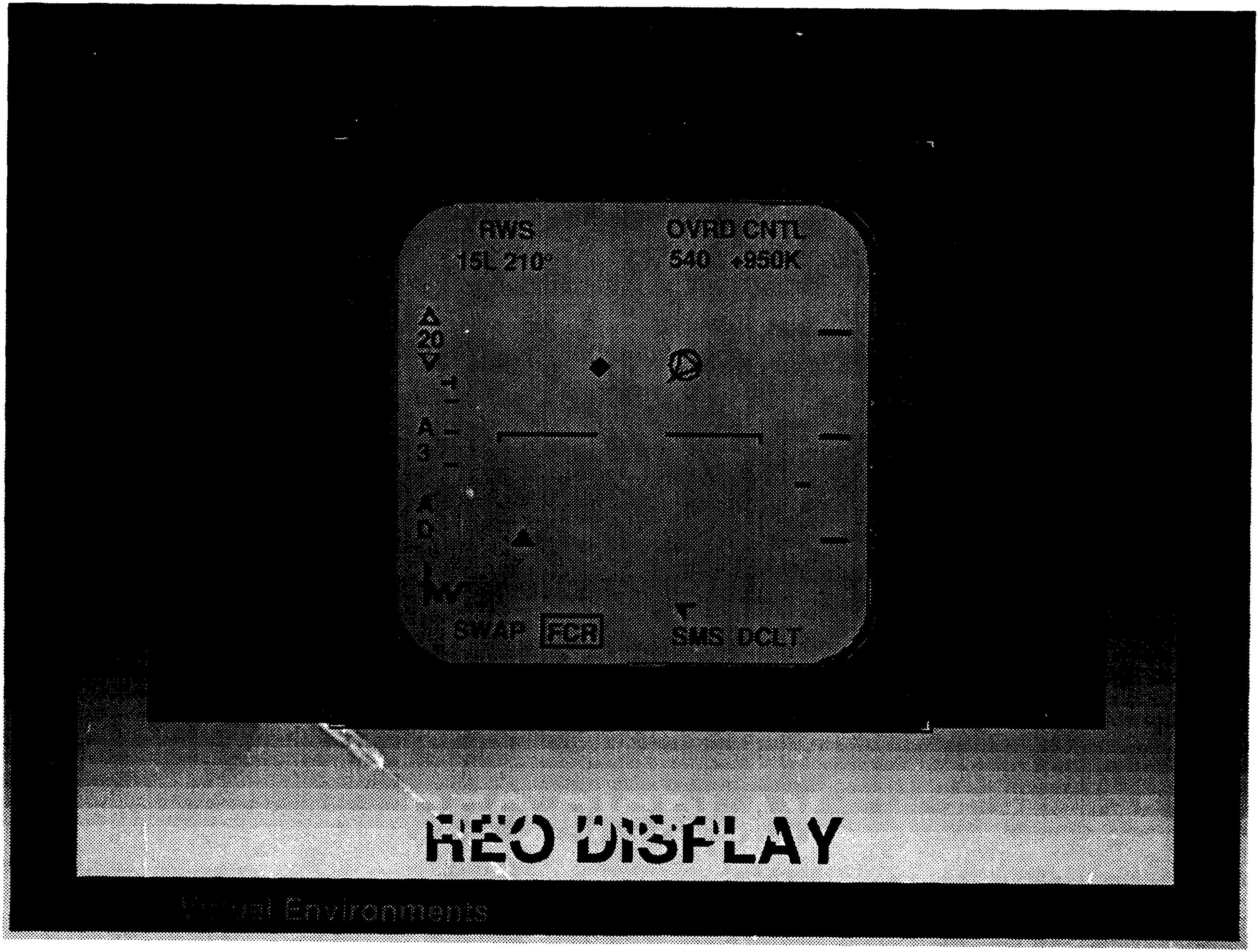

VERITY SCALE
Complete Correspondence To "Natural Laws"
Tele-presence
Alternative Realities
Novel Environments
Virtual Environments

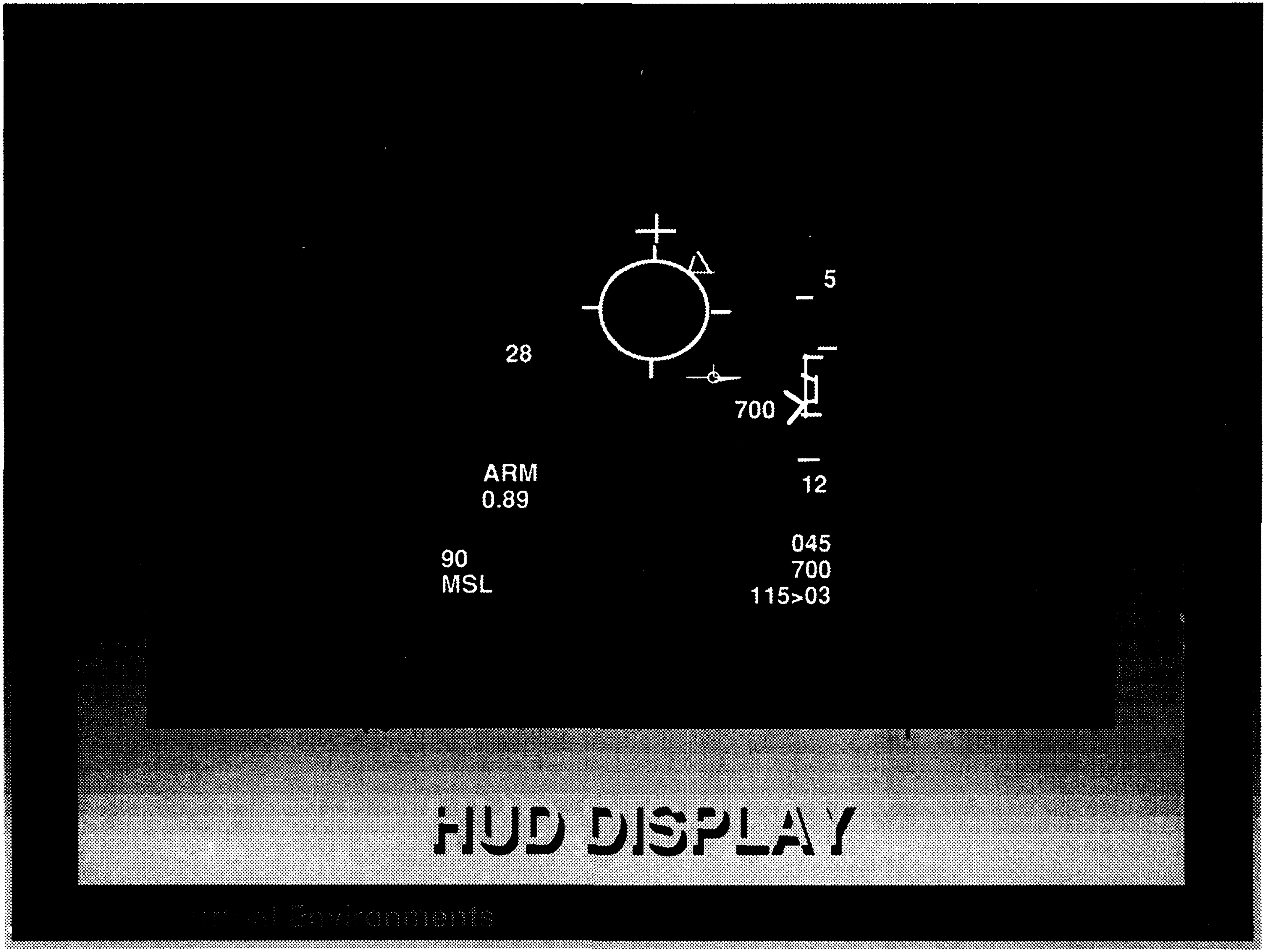

INTEGRATION SCALE
TOTAL INCLUSION
SHARED CONTROL
BATCH PROCESSING
Virtual Environments

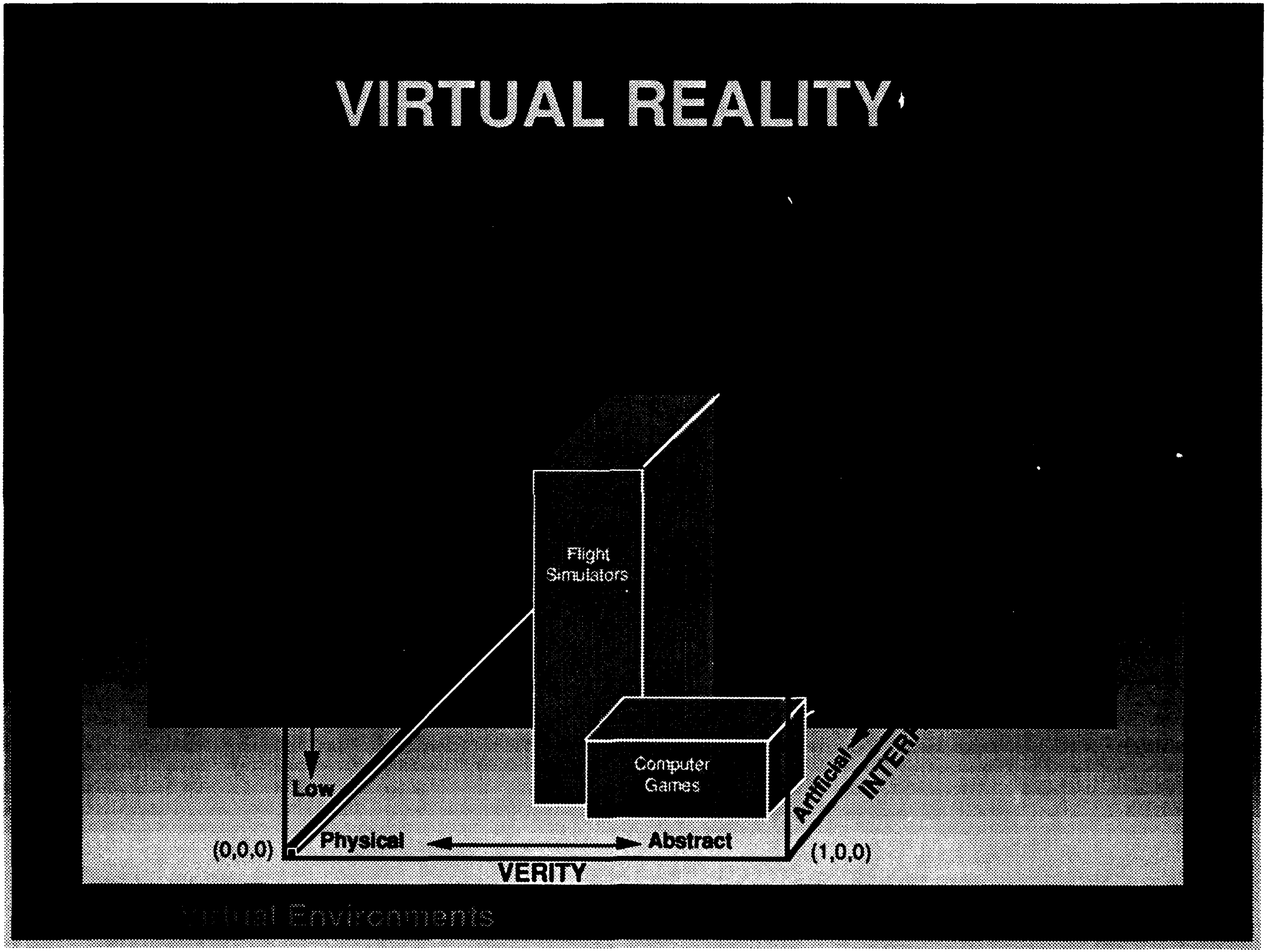

Physical Space
Patron
Sensors
Effectors
Puppet
Virtual Space
CYBERNETIC FEEDBACK LOOP
(Walsher, 1991)

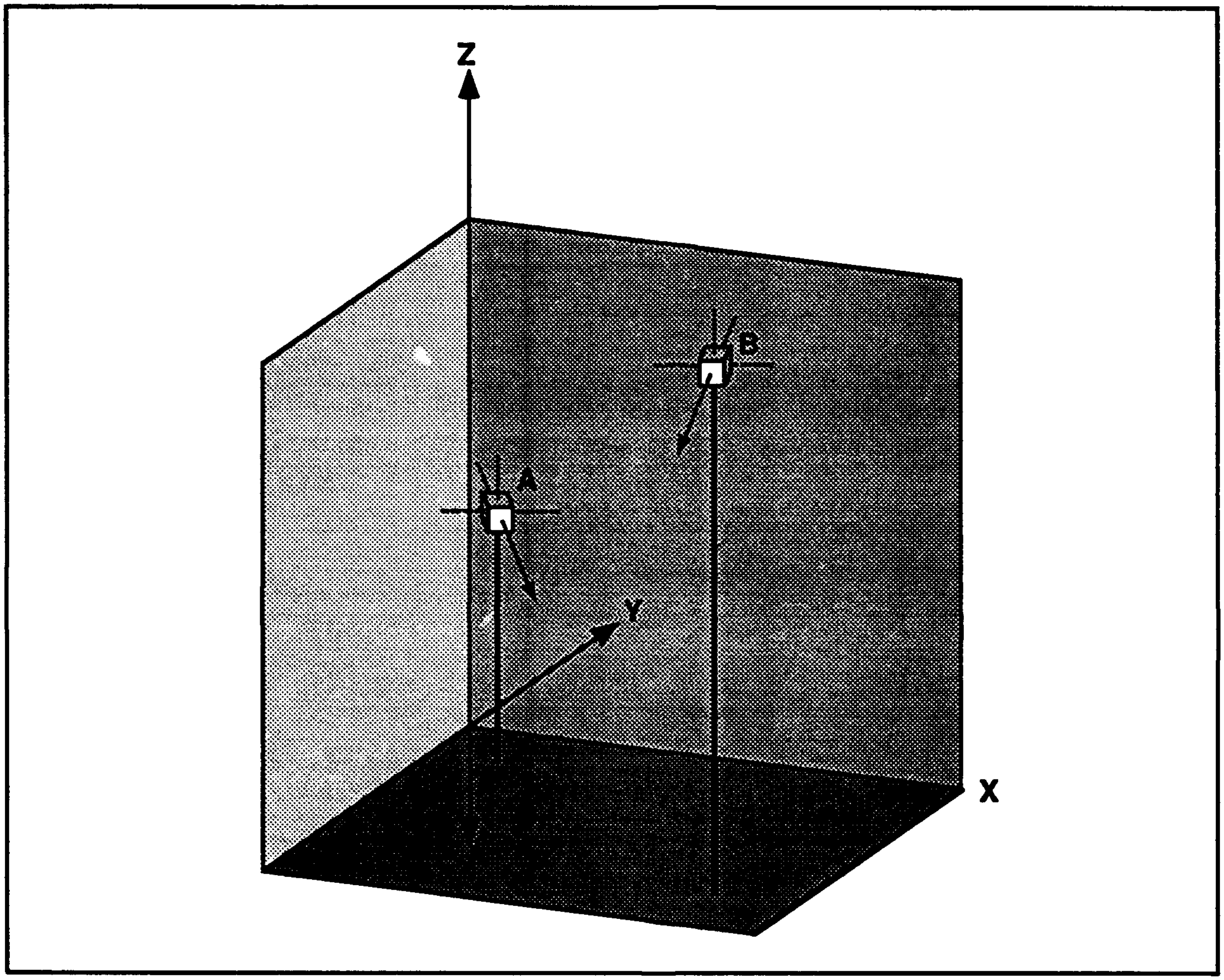

INTERFACE SCALE
NATURAL
INTERFACE
ARTIFICIAL
INTERFACE
Environments


VIRTUAL REALITY
Low
(0,0,0)
Physical
Abstract
(1,0,0)
VERITY
Artificial
INTER
Virtual Environments

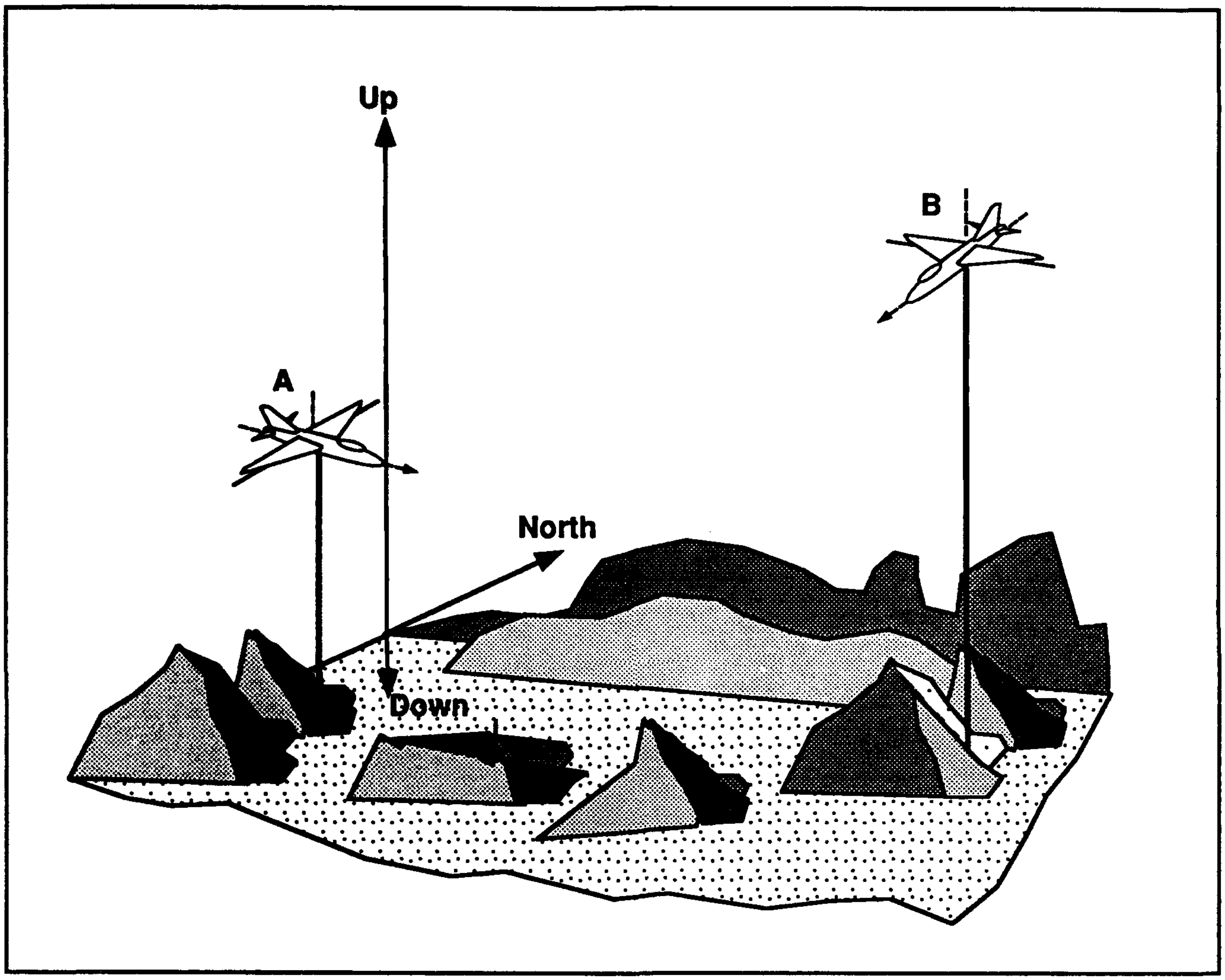

RWS
15L 210°
OVRD CNTL
540 +950K
SWAP
FCR
SMS DCLT
DISPLAY
Environments


28
5
700
12
ARM
0.89
90
MSL
045
700
115>03
HUD DISPLAY

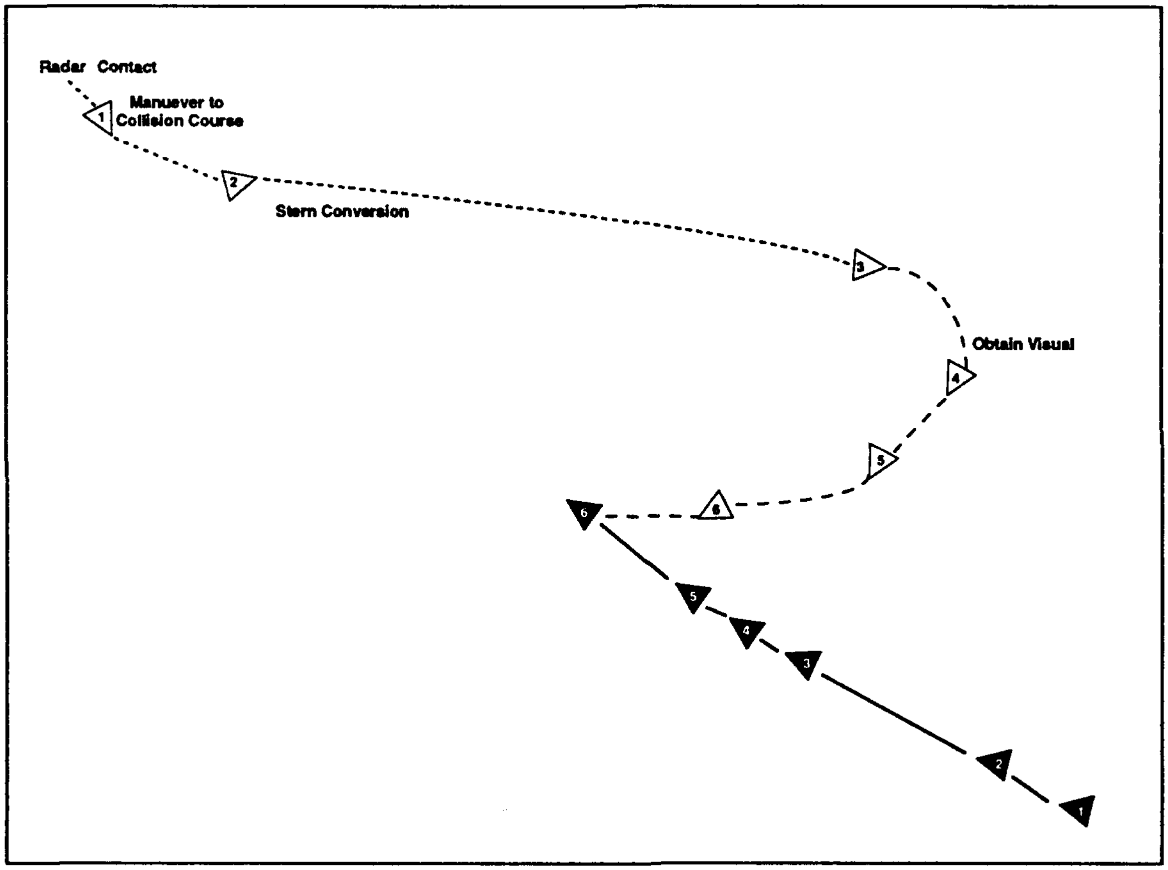

VIRTUAL REALITY
Flight Simulators
Computer Games
Low
Artificial
INTER
(0,0,0)
Physical
Abstract
(1,0,0)
VERITY
Virtual Environments



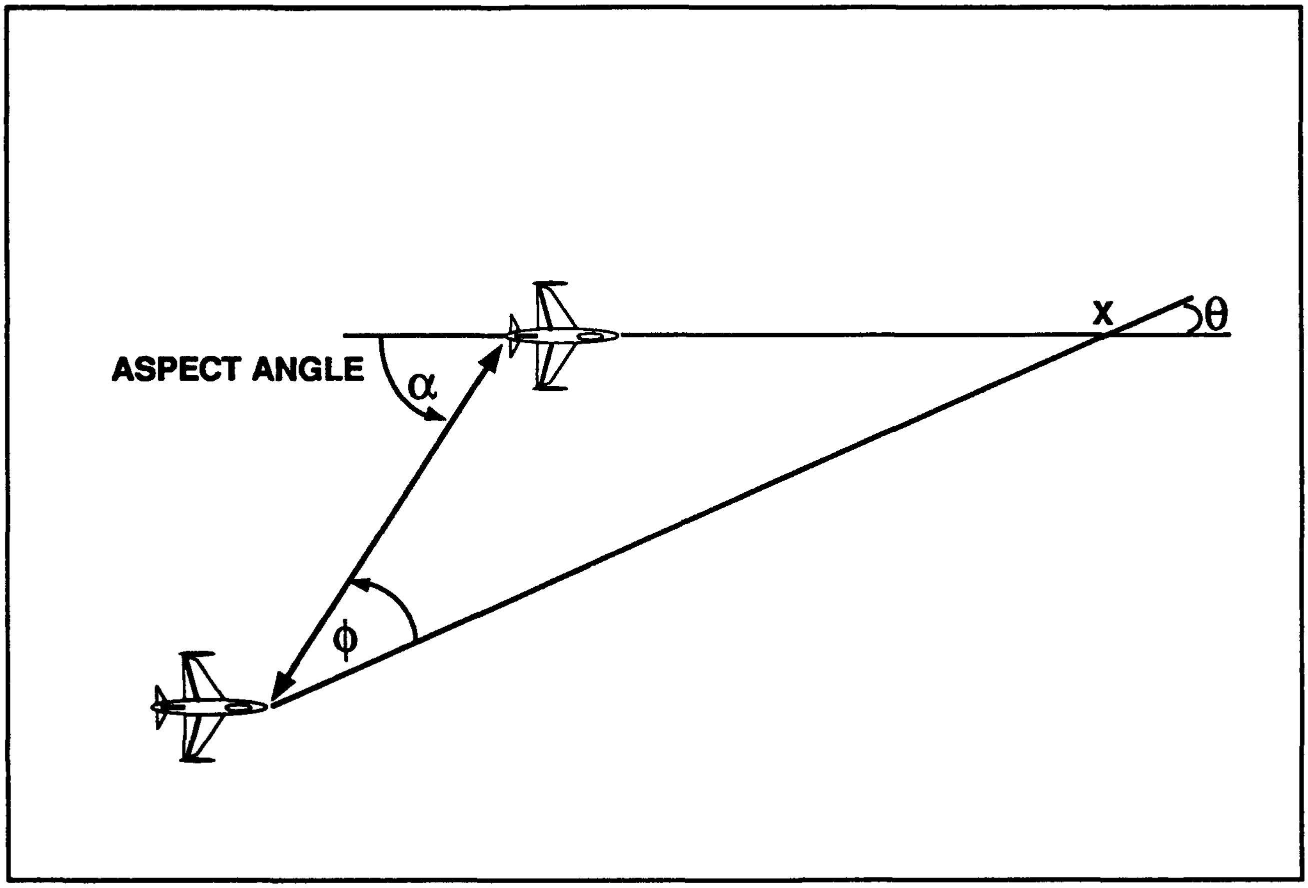
Spatial awareness consists of a description of each object's 3 coordinates of location, 3 coordinates of orientation and a motion velocity vector.



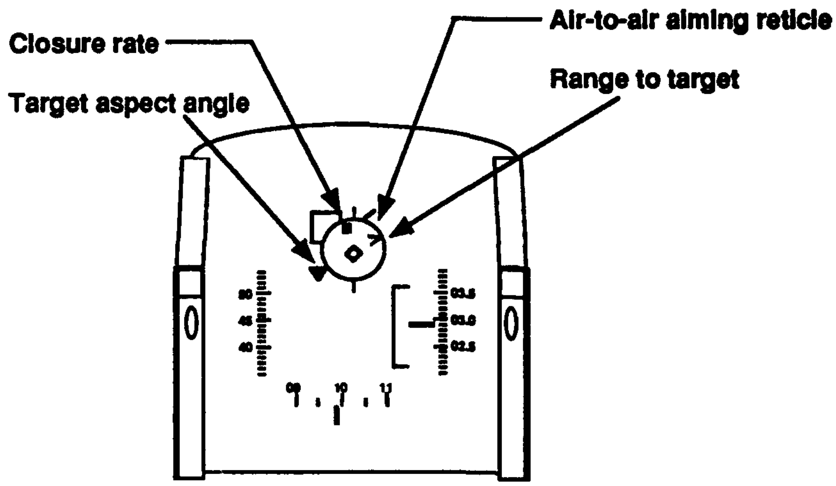
The air-to-air intercept as a spatial awareness problem.



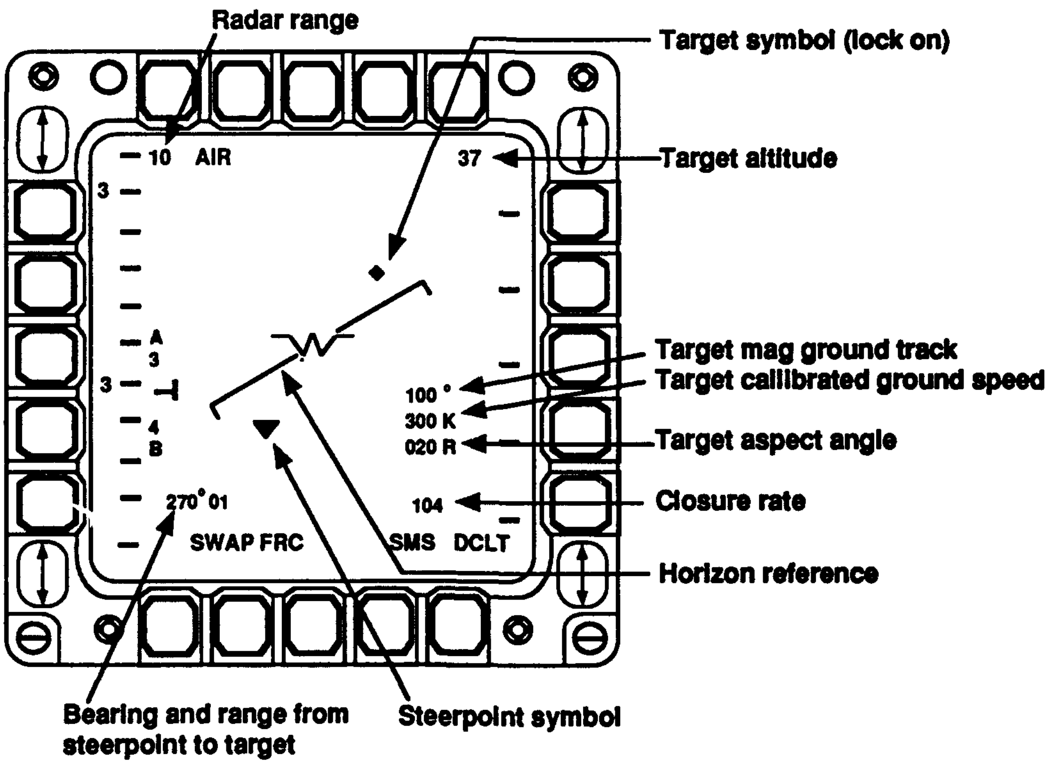
The Basic Air-to-Air Intercept



The geometry of the air-to-air intercept.

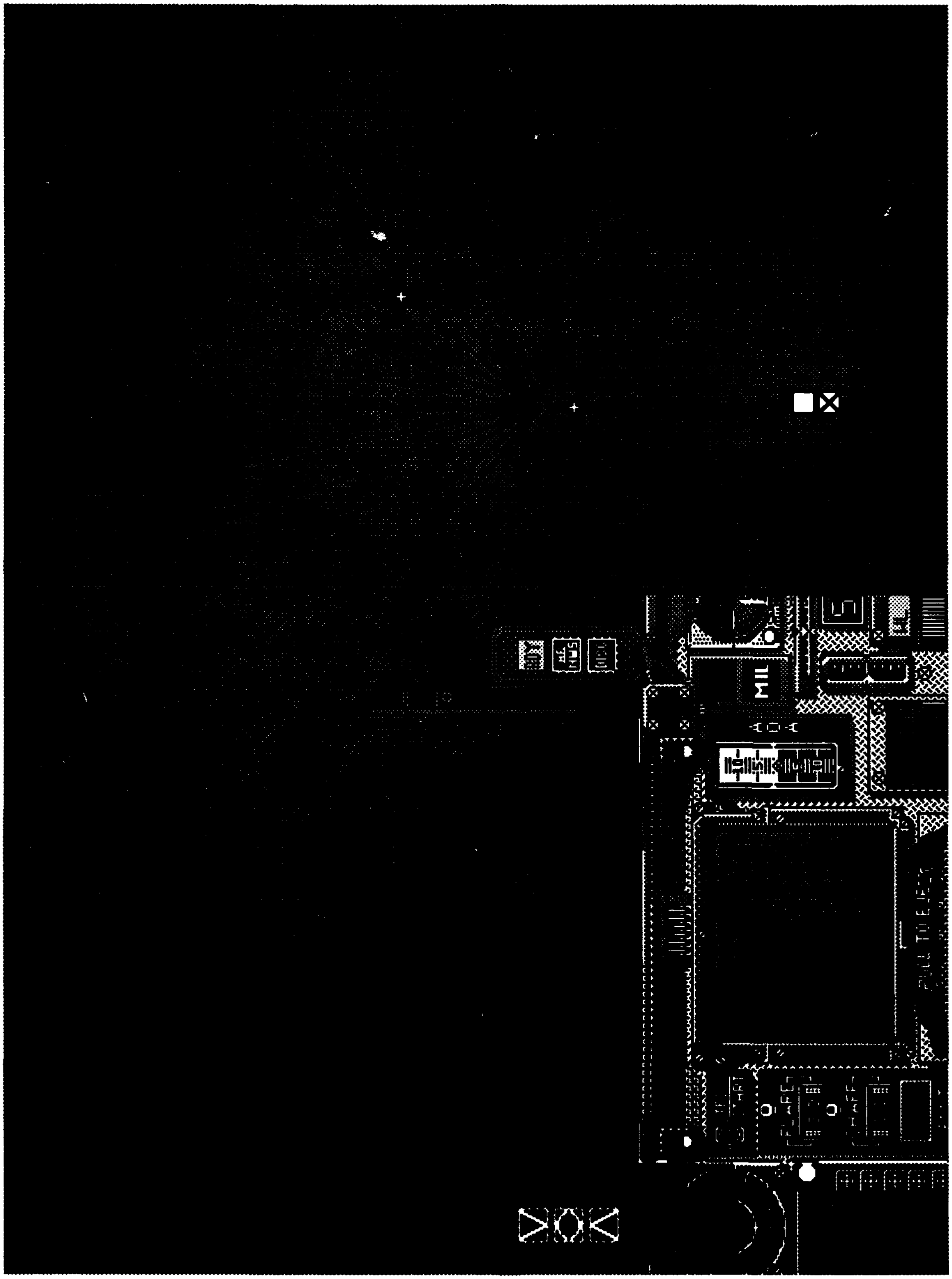


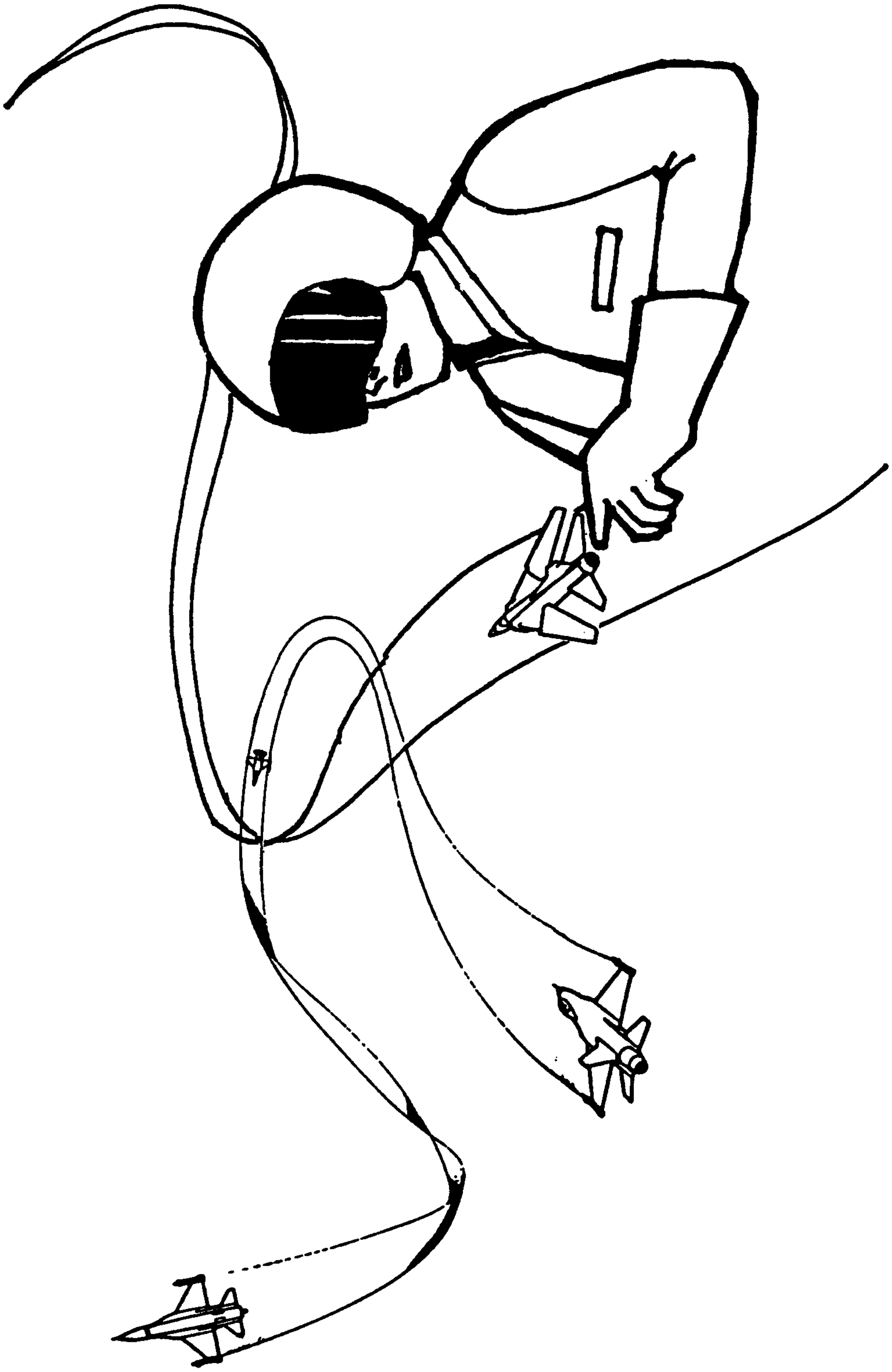
Head Up Display (HUD) in Air-to-Air Mode

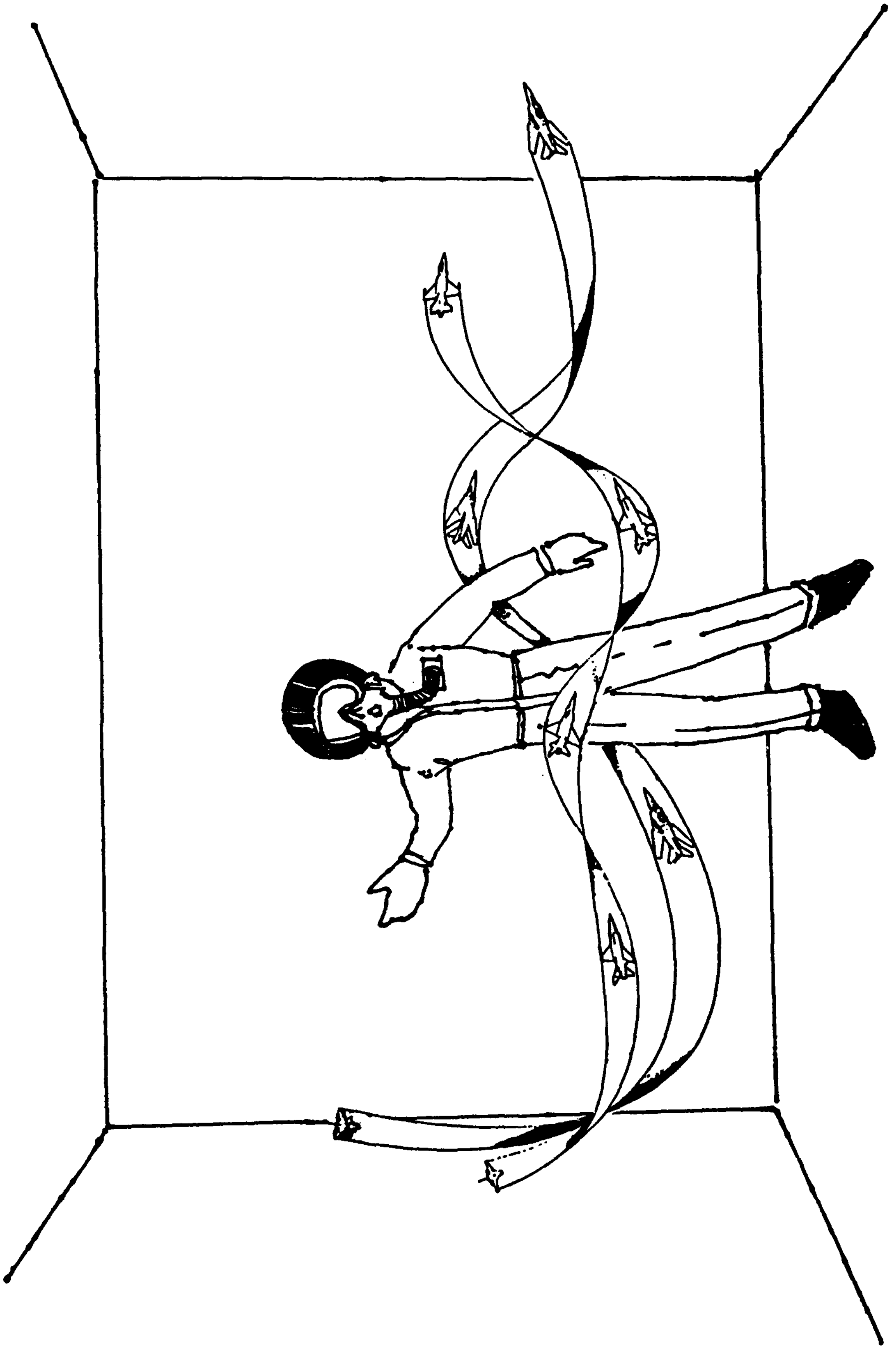


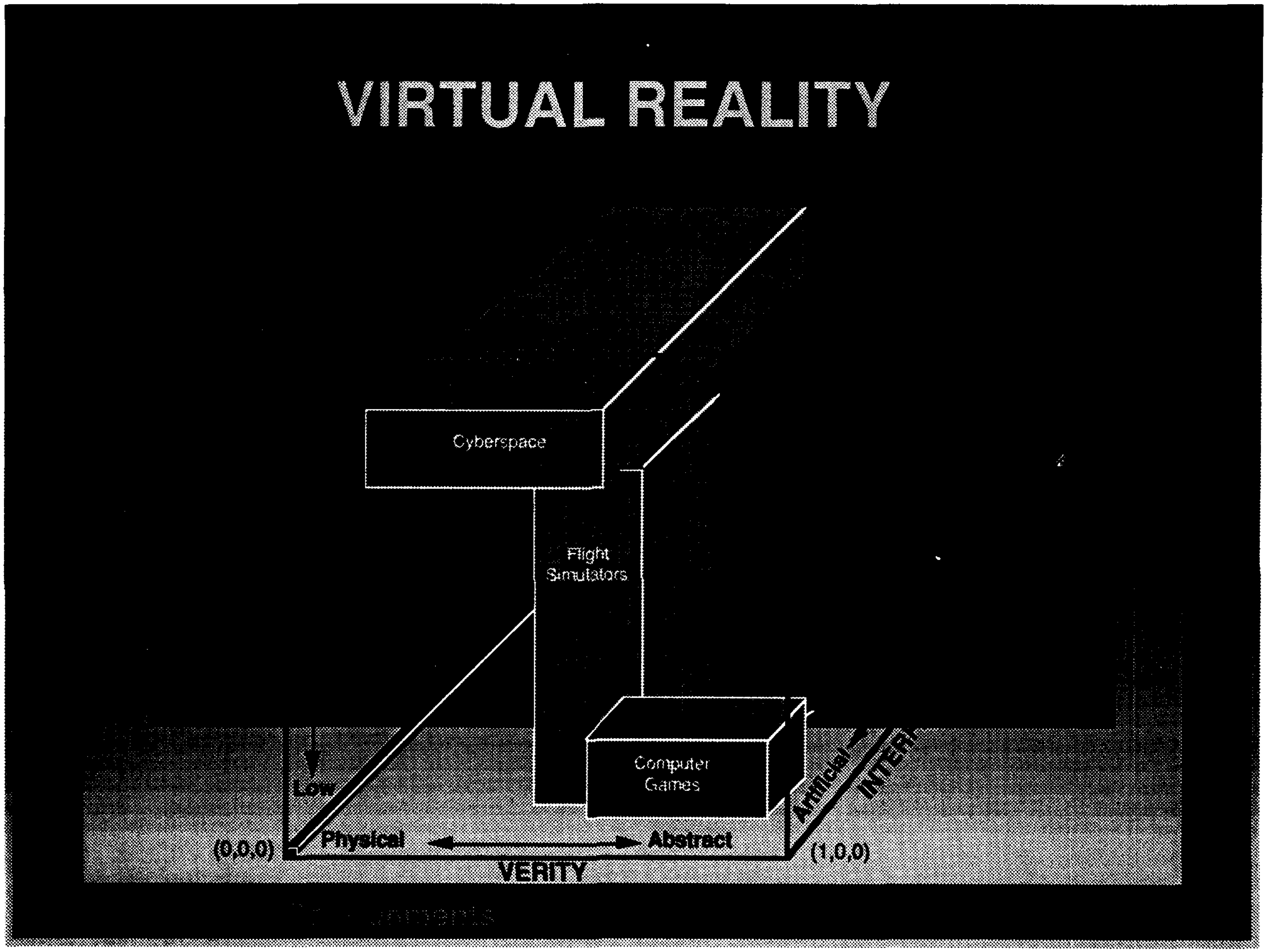
Radar Display (REO) in Single Target Track Submode

Spatial Instruments Representing the Air Space During the Intercept








VIRTUAL REALITY
Cyberspace
Flight Simulators
Computer Games
Low
(0,0,0)
Physical
Abstract
VERITY
(1,0,0)
Artificial

BEHAVIORAL REQUIREMENTS FOR TRAINING & REHEARSAL IN VIRTUAL ENVIRONMENTS

ARMY RESEARCH INSTITUTE

Dr. Bruce W. Knerr
Army Research Institute
PM TRADE Field Unit
Orlando, FL

PM TRADE FIELD UNIT

OUR CONTEXT FOR VIRTUAL ENVIRONMENT RESEARCH

- TRAINING DEVICES AND SIMULATORS
- DISTRIBUTED INTERACTIVE SIMULATION (DIS)
  - SIMNET -> CCTT
  - BDS-D
  - UPAS
- SUPERTROOP & I-PORT
  - SOLDIER INTEGRATED PERFORMANCE ENSEMBLE (SIPE)
  - SNOWBIRD CONFERENCE
- ASB 91 SUMMER STUDY ON ARMY SIMULATION STRATEGY
- NTSC VIRTUAL ENVIRONMENT TRAINING TECHNOLOGY (VETT)

THE MEMBERS OF THE STUDY TEAM BELIEVE THAT THE APPROACH WE HAVE CALLED THE ELECTRONIC BATTLEFIELD CAN MAKE MAJOR IMPROVEMENTS IN THE WAY THE ARMY DOES DEVELOPMENT, TESTING AND TRAINING. IT CAN EITHER REDUCE COST OVER TIME, OR IMPROVE PERFORMANCE, OR RESULT IN A COMBINATION OF LESSER AMOUNTS OF BOTH.

RECOMMENDATION: AGGRESSIVELY ADOPT THE ELECTRONIC BATTLEFIELD TECHNOLOGY FOR COLLECTIVE COMBINED ARMS TRAINING.

ARMY SCIENCE BOARD 1991 SUMMER STUDY ON SIMULATION STRATEGY

VIRTUAL ENVIRONMENTS RESEARCH GOALS

IDENTIFY VIRTUAL ENVIRONMENT INTERFACE REQUIREMENTS FOR MISSION PLANNING & REHEARSAL, MISSION-SPECIFIC TRAINING, AND COMBAT PROFICIENCY TRAINING FOR THE DISMOUNTED SOLDIER

EXAMINE FEASIBILITY OF VIRTUAL ENVIRONMENT TECHNOLOGY TO SUPPORT MISSION PLANNING AND POST-MISSION FEEDBACK FOR THE UNIT COMMANDER

DEVELOP SUPPORTING TRAINING TECHNOLOGY

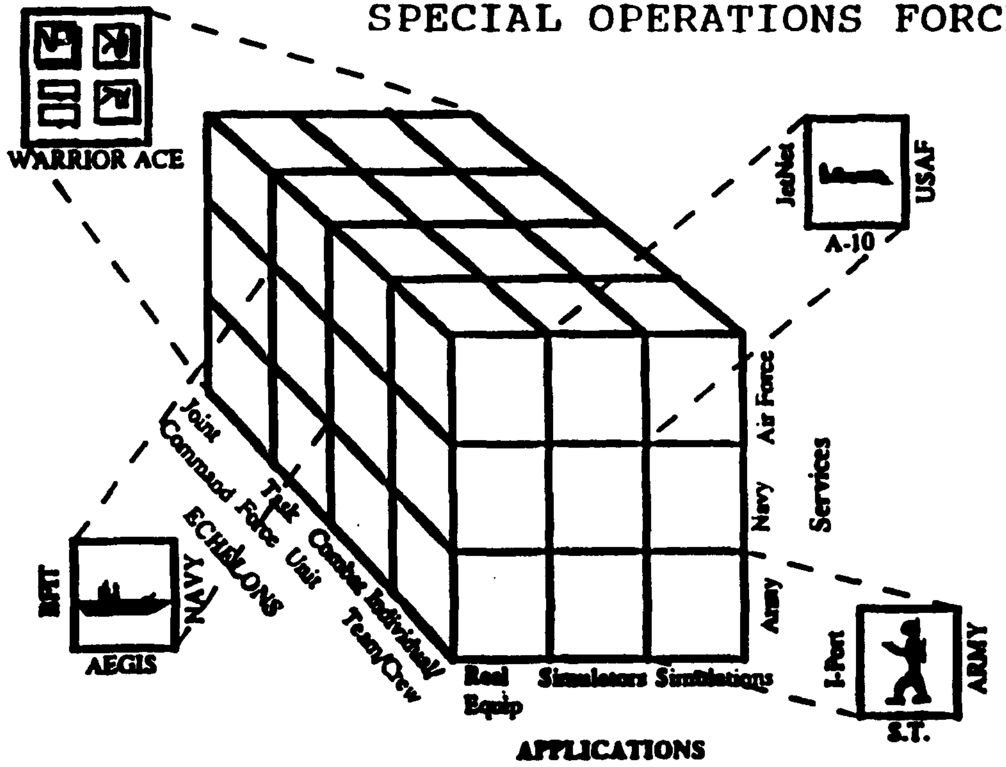
- VALIDATION OF TRAINING AND PERFORMANCE TRANSFER
- METHODOLOGY FOR PERFORMANCE MEASUREMENT AND FEEDBACK
- METHODOLOGY FOR TRAINING PROGRAM DEVELOPMENT

BEHAVIORAL REQUIREMENTS FOR TRAINING AND REHEARSAL IN VIRTUAL ENVIRONMENTS

OBJECTIVE: TO IDENTIFY THE BEHAVIORAL REQUIREMENTS FOR NETWORKED INDIVIDUAL SOLDIER PORTAL (I-PORT) INTO NETWORKED SIMULATIONS FOR PURPOSES OF TRAINING AND MISSION PLANNING & REHEARSAL.

PROBLEMS: NEED TO TRAIN DISMOUNTED AND LIGHT INFANTRY USING THE COMBINED ARMS TACTICAL TRAINER (CCTT)

NEED FOR MISSION PLANNING, REHEARSAL, AND MISSION-SPECIFIC TRAINING CAPABILITY FOR GROUND SPECIAL OPERATIONS FORCES



SCENARIOS FOR USING VIRTUAL ENVIRONMENTS

MISSION PLANNING & REHEARSAL

MISSION-SPECIFIC TRAINING

COMBAT PROFICIENCY TRAINING

COMBAT PROFICIENCY TRAINING

IMPROVE UNIT PROFICIENCY IN A VARIETY OF SITUATIONS

SOLDIERS ARE QUALIFIED IN INDIVIDUAL SKILLS

GENERIC MISSION, TERRAIN, & OPFOR

USUALLY REAL TIME

MISSION PLANNING & REHEARSAL

- SUPPORT PLAN DEVELOPMENT & TRYOUT FOR SPECIFIC OPERATION
- FAMILIARIZE SOLDIERS WITH THEIR ROLES (CRAWL & WALK)
- COGNITIVE EMPHASIS (WHAT, WHEN, & WHERE)
- INVOLVES UNIT & INDIVIDUAL TASKS
- SOLDIERS ARE QUALIFIED IN INDIVIDUAL SKILLS
- SPECIFIC MISSION, TERRAIN, & OPFOR
- MAY DIFFER FROM REAL TIME (FASTER OR SLOWER)
- FEEDBACK DIRECTED TOWARD IMPROVING THE PLAN

MISSION-SPECIFIC TRAINING

- IMPROVE CAPABILITY TO CARRY OUT A PLAN FOR A SPECIFIC OPERATION SUCCESSFULLY
- INVOLVES UNIT & INDIVIDUAL TASKS
- SOLDIERS ARE QUALIFIED IN INDIVIDUAL SKILLS
- SPECIFIC MISSION, TERRAIN, & OPFOR
- SOLDIERS PRACTICE THEIR ROLES (RUN)
- COGNITIVE & PSYCHOMOTOR (WHAT, WHEN, WHERE, & HOW)
- REAL TIME

WHAT IS A VIRTUAL ENVIRONMENT ?

A SIMULATED SPACE WITH WHICH THE VIEWER DIRECTLY INTERACTS VIA HEAD-MOUNTED DISPLAYS, SENSOR-EQUIPPED GLOVES, AND SPECIAL EQUIPMENT. IT IS DISTINGUISHED FROM MOST VISUAL SIMULATIONS IN THAT THE 'VEHICLE' IS THE PARTICIPANT'S OWN BODY, RATHER THAN AN AIRCRAFT, TANK, ETC.

A VIRTUAL ENVIRONMENT REQUIRES

- 3-D REAL-TIME INTERACTIVE GRAPHICS (STEREOPSIS IF NEEDED)
- MULTIPLE SENSES BEYOND GRAPHICS (SOUND, TOUCH...)
- DIRECT MANIPULATION OF OBJECTS (E.G., BY A GLOVE)
- FREE MOTION OF THE EYEPOINT WITHIN THE SPACE
- MULTIPLE INTERACTING, MUTUALLY VISIBLE HUMANS

"Is that you, or am I experiencing Artificial Reality?"

"SATISFACTORY SEX, IN A FORM THAT COULD BE TRANSMITTED LONG-DISTANCE, BY COMPUTER, COULD BE AVAILABLE AS EARLY AS THE YEAR 2050."

JOEL GARREAU
WASHINGTON POST SUNDAY MAGAZINE
DECEMBER 30, 1990

ARI OPTION TO NTSC VETT CONTRACT

OBJECTIVES

EXAMINE VE CAPABILITIES AND TRENDS VIS A VIS INDIVIDUAL COMBAT SIMULATIONS (ICS)

CONSIDER CAPABILITIES OF THREE LEVELS OF ICS TO SUPPORT DISMOUNTED INFANTRY FUNCTIONS

LEVEL 1 (SIMNET/CCTT EQUIVALENT)

- MULTI-SCREEN VISUAL DISPLAYS
- SPEAKERS FOR BATTLEFIELD SOUNDS
- JOYSTICKS & SIMILAR DEVICES
- DI ICONS

LEVEL 2 (3-5 YEARS)

- LOW RESOLUTION HMD
- SENSING OF LIMB & BODY POSITION
- MOVEMENT IN PLACE
- HEADPHONES FOR LOCALIZED SOUND
- LIMITED SPEECH RECOGNITION (SD)
- SPECIALIZED CONTROL & SENSING DEVICES
- LOW-FIDELITY ARTICULATED DI ICONS

LEVEL 3 (>5 YEARS)

- HIGH RESOLUTION HMD
- EYE TRACKING
- SENSORY STIMULATION OF WHOLE BODY MOVEMENT
- ADVANCED SPEECH RECOGNITION (SI)
- PROGRAMMABLE GENERAL-PURPOSE CONTROL & SENSING DEVICES
- FULLY ANIMATED DI ICONS

ARI OPTION TO NTSC VETT CONTRACT

CONCLUSIONS

ICS IS A LOGICAL PROGRESSION OF DIS CAPABILITIES

THERE ARE POTENTIAL TRAINING & MISSION REHEARSAL BENEFITS TO BE OBTAINED FROM THE TECHNOLOGY AVAILABLE NOW

DIFFICULT PROBLEMS

- MISSION-SPECIFIC TRAINING
- URBAN OR CLOSE-IN OPERATIONS
- CONTROL AND MANIPULATION OF WEAPONS AND EQUIPMENT
- WHOLE BODY MOVEMENT

MAKING VIRTUAL ENVIRONMENTS A REALITY

- ENGINEERING/COMPUTER SCIENCE ISSUES
  - VISUAL DISPLAYS
  - REAL-TIME IMAGERY CONSTRUCTION
  - HEAD & BODY TRACKING
  - TACTILE & FORCE SENSING & FEEDBACK
  - DATABASE GENERATION
- BEHAVIORAL ISSUES
  - INTERFACE REQUIREMENTS
  - PERFORMANCE MEASUREMENT & FEEDBACK
  - PERFORMANCE & TRAINING TRANSFER
  - TRAINING STRATEGIES

AN EXAMPLE OF WHAT WE DON'T KNOW

WHAT VISUAL DISPLAY UPDATE RATE IS REQUIRED FOR A PERCEPTION OF CONTINUOUS MOVEMENT?

SOURCE	UPDATES/SEC
FLIGHT SIMULATORS	60
ENTERTAINMENT INDUSTRY	30
THRU SIMULATED BUILDING (UNC)	20
DRIVER SIMULATOR (STI)	20
PARACHUTE MANEUVER SIMULATOR (STI)	10

PRELIMINARY VIRTUAL ENVIRONMENT INTERFACE ISSUES

- INPUT (SOLDIER -> COMPUTER) REQUIREMENTS
    - MOVEMENT TRACKING
        - GROSS
        - FINE
            - HEAD/EYE
            - HAND/FINGER
    - VOICE RECOGNITION

- OUTPUT (COMPUTER -> SOLDIER) REQUIREMENTS
    - VISUAL DISPLAYS
        - BRIGHTNESS
        - RESOLUTION
            - NEAR OBJECTS
            - FAR OBJECTS
        - UPDATE RATE
        - MOVEMENT RATE & LAG
        - *HEAD MOVEMENT COMPENSATION*
        - FIELD OF VIEW
        - STEREOSCOPIC VS MONOCULAR DISPLAYS
        - COLOR
    - TERRAIN REPRESENTATION
        - AREA
        - LEVEL OF DETAIL (GRANULARITY)
    - FUNCTIONAL VS PHYSICAL FIDELITY
        - ENVIRONMENT
        - WEAPONS & EQUIPMENT
    - TACTILE FEEDBACK
    - FORCE FEEDBACK
    - AUDITORY CUES/VOICE SYNTHESIS
        - LOCALIZATION
        - LIBRARY

- HUMAN FACTORS ISSUES

BEHAVIORAL REQUIREMENTS FOR TRAINING AND REHEARSAL IN VIRTUAL ENVIRONMENTS (ILLUSION ENGINEERING, INC)

DEVELOP PRACTICAL USAGE SCENARIOS AND TASKS TO BE PERFORMED FOR

- COMBAT PROFICIENCY TRAINING
- MISSION PLANNING & REHEARSAL
- MISSION-SPECIFIC TRAINING

DEVELOP TAXONOMY OF SIGNIFICANT VIRTUAL ENVIRONMENT INTERFACE CHARACTERISTICS

DETERMINE INTERFACE REQUIREMENTS FOR EACH TYPE OF TASK

- SUMMARIZE LITERATURE
- IDENTIFY KNOWLEDGE GAPS

DEVELOP RESEARCH PLAN TO FILL GAPS

IDENTIFY REQUIREMENTS & COST FOR RESEARCH TEST BED

VIRTUAL ENVIRONMENTS RESEARCH GOALS

IDENTIFY VIRTUAL ENVIRONMENT INTERFACE REQUIREMENTS FOR MISSION PLANNING & REHEARSAL, MISSION-SPECIFIC TRAINING, AND COMBAT PROFICIENCY TRAINING FOR THE DISMOUNTED SOLDIER

EXAMINE FEASIBILITY OF VIRTUAL ENVIRONMENT TECHNOLOGY TO SUPPORT MISSION PLANNING AND POST-MISSION FEEDBACK FOR THE UNIT COMMANDER

DEVELOP SUPPORTING TRAINING TECHNOLOGY

- VALIDATION OF TRAINING AND PERFORMANCE TRANSFER
- METHODOLOGY FOR PERFORMANCE MEASUREMENT AND FEEDBACK
- METHODOLOGY FOR TRAINING PROGRAM DEVELOPMENT

CREW, GROUP, TEAM, AND UNIT TECHNOLOGY SUB-GROUP

Opening Remarks

Joint Collective Training R&D Effort:
Dr. Frank Moses, ARI

Dr. Eduardo Salas, NTSC
(No hard copies available)

ASSESSMENT OF JOINT TRAINING STRATEGIES FOR INCREASING WARFIGHTING EFFECTIVENESS

Participating Organizations:

ARI

NTSC

ALHR & ASD/XR

Dr. Frank Moses
POC @ ARI
Tel: 274-8293)

4/23/92

ASSESSMENT OF JOINT TRAINING STRATEGIES

GOAL

DEVELOP TECHNOLOGIES FOR --

- TRAINING JOINT SERVICE TASKS -- MIXES OF GROUND, ROTARY, FIXED-WING, BEACHHEAD ASSAULT, AND SUPPORTING NAVAL FORCES
- ASSESSING JOINT TRAINING STRATEGIES -- SCHEDULES OF TRAINING EVENTS AND DISTRIBUTION OF RESOURCES

NEED

- INCREASE JOINT TRAINING EFFECTIVENESS THROUGH BEST USE OF DISTRIBUTED INTERACTIVE SIMULATION

2/12/92

R & D OBJECTIVES & APPROACH

- DEVELOP OR ADAPT A TRAINING TESTBED*
- DEVELOP PROTOTYPE METHODS FOR AFTER ACTION REVIEWS (AARs) AND OTHER FEEDBACK TECHNIQUES
- DEMONSTRATE TRAINING PRINCIPLES/PROCEDURES, AARs, AND OTHER TRAINING AND PERFORMANCE FEEDBACK TECHNIQUES
- ANALYTICALLY ESTIMATE THE TRADEOFFS AMONG ALTERNATIVE TRAINING PRINCIPLES/PROCEDURES

---

* A DATABASE WITH (A) GENERIC WARTIME SCENARIOS REQUIRING JOINT OPERATIONS AND (B) METHODS/TECHNOLOGIES FOR SELECTIVE REPLAY AND MEASUREMENT OF COLLECTIVE TRAINING PERFORMANCE

2/12/92

R & D SCOPE

- ADDRESS MULTI-SERVICE COMBAT TRAINING RE: BATTLE PLANNING, PREPARATION, AND EXECUTION
  - - - CLOSE AIR SUPPORT, SAFE PASSAGE
  - - - COMBINED AMPHIBIOUS AND LAND ASSAULT

- FORCE-LEVEL TRAINING
  - - - BOTH HORIZONTAL AND VERTICAL ORGANIZATIONS
  - - - COMBINATIONS OF ANY TWO-OR-MORE ECHELONS

2/12/92

COLLECT CRITICAL DATA

- FROM OBSERVATIONS OF TRAINING WITH SIMULATOR NETWORKS

  - - IDENTIFY CRITICAL TASKS FOR COMBAT SCENARIOS

  - - IDENTIFY MEASUREMENT ISSUES AND METHODS

- ANALYZE OBSERVATIONS/DATA IN TERMS OF

  - - PERFORMANCE REVIEW
  - - CROSS-TRAINING
  - - FREQUENCY OF TRAINING
  - - GUIDED PRACTICE
  - - ETC

2/11/92

HOW TO GET THERE

ENHANCED TRAINING STRATEGIES

(FTX .. DEPLEX .. LFX .. CPX ...)

MEASURES
Assessment Data

RESOURCES
Logistics
Spaces
Ranges

R & D

SCENARIOS
Objectives
Conditions
Tasks-Functions

EMERGING TECHNOLOGIES *

* Models, Simulations, Distributed Interactive Simulations/Networks, Virtual Reality, etc.

RELATED INITIATIVES

LOUISIANA MANEUVERS CONCEPT

REALISTIC (LG UNIT) EXERCISES

"ACHIEVE WARTIME REALISM"

★★★★ Commanders Conference

HISTORICALLY: ARMY-AIR

LOUISIANA MANEUVERS 1941

CONCEPT

- GOAL: BATTLEFIELD REALISM; VALIDATE TRAINING, ORGANIZATION AND DOCTRINE
- RED/BLUE FIELD ARMY WITH AIR TASK FORCE
- OFFENSIVE MISSION FOR BOTH SIDES
- FREE PLAY, FIRE MARKERS AND UMPIRES
- NO SCRIPTED SCENARIOS AND ~~MANUAL~~ MINIMAL CONTROL MEASURES
- STRESS C2, MANEUVER, MOVEMENT AND LOGISTICS
- UMPIRE MANUAL USED TO RESOLVE ENGAGEMENTS
- FIRST USE OF AFTER ACTION CRITIQUE

LARGE SCALE MEETING ENGAGEMENTS

★★★★ Commanders Conference

LOUISIANA MANEUVERS 1941

LESSONS LEARNED

- LARGE SCALE EXERCISES ARE EFFECTIVE
  - -- TRAINS SR CDR'S & STAFF OFFICERS
  - -- COUNTERPRODUCTIVE FOR GROUND TROOPS
- UMPIRE MANUAL VALID MEANS OF RESOLVING COMBAT
  - REVISION OF SOME TABLES REQUIRED
  - DIDN'T REFLECT ACTUAL CAPABILITY OF ALL UNITS AND WEAPONS
- FOLLOW ON TRAINING PROGRAM FOCUSED AT SMALL UNIT LEVEL
  - STANDARDIZED PERFORMANCE MEASURES
  - CENTRALIZED EVALUATION
- AFTER ACTION CRITIQUE - EFFECTIVE TOOL

EFFECTIVE TRAINING TOOL FOR TARGET AUDIENCES

★★★★ Commanders Conference

MODERN: ARMY ++ ⇒ JOINT

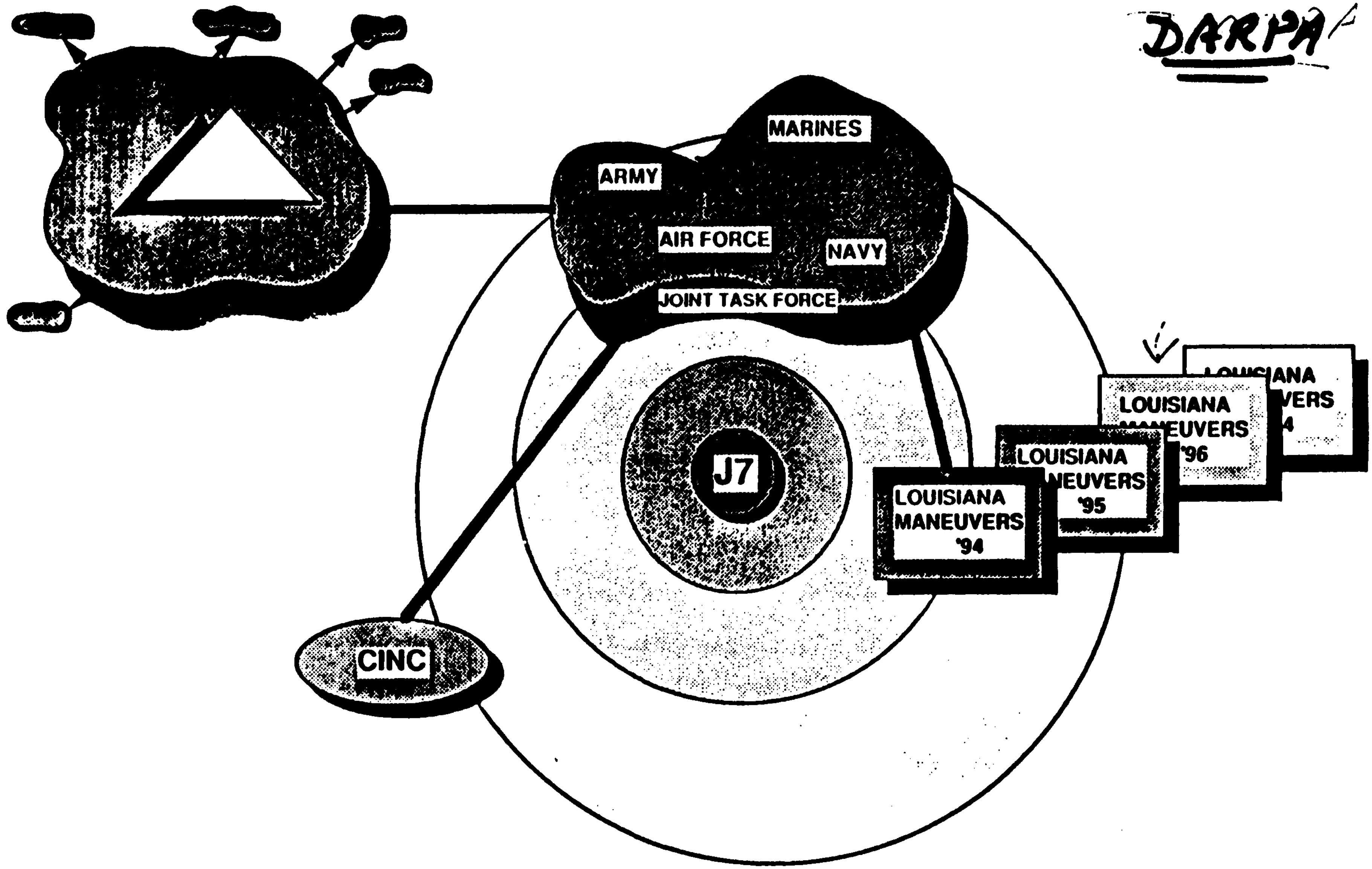
LOUISIANA MANEUVERS 1994

- TNG AUDIENCE
  - -- THEATRE ARMY
  - -- ARMY GROUP
  - -- FIELD ARMY
  - -- CORPS
  - -- DIVISION (EXERCISE CELL/FIELD LOCATIONS?)
- AREAS OF EMPHASIS:
  - -- SR CDR & STAFF OFFICER TNG
  - -- JOINT/COMBINED OPERATIONS
  - -- CAMPAIGN PLANNING
  - -- COMMAND & CONTROL
  - -- FORCE PACKAGING
  - -- FORCE PROJECTION
  - -- LARGE SCALE MANEUVER
  - -- LARGE SCALE MOVEMENT
  - -- SUSTAINMENT
  - -- INTELLIGENCE
  - -- REDEPLOYMENT

ALL FORCE TRAINING

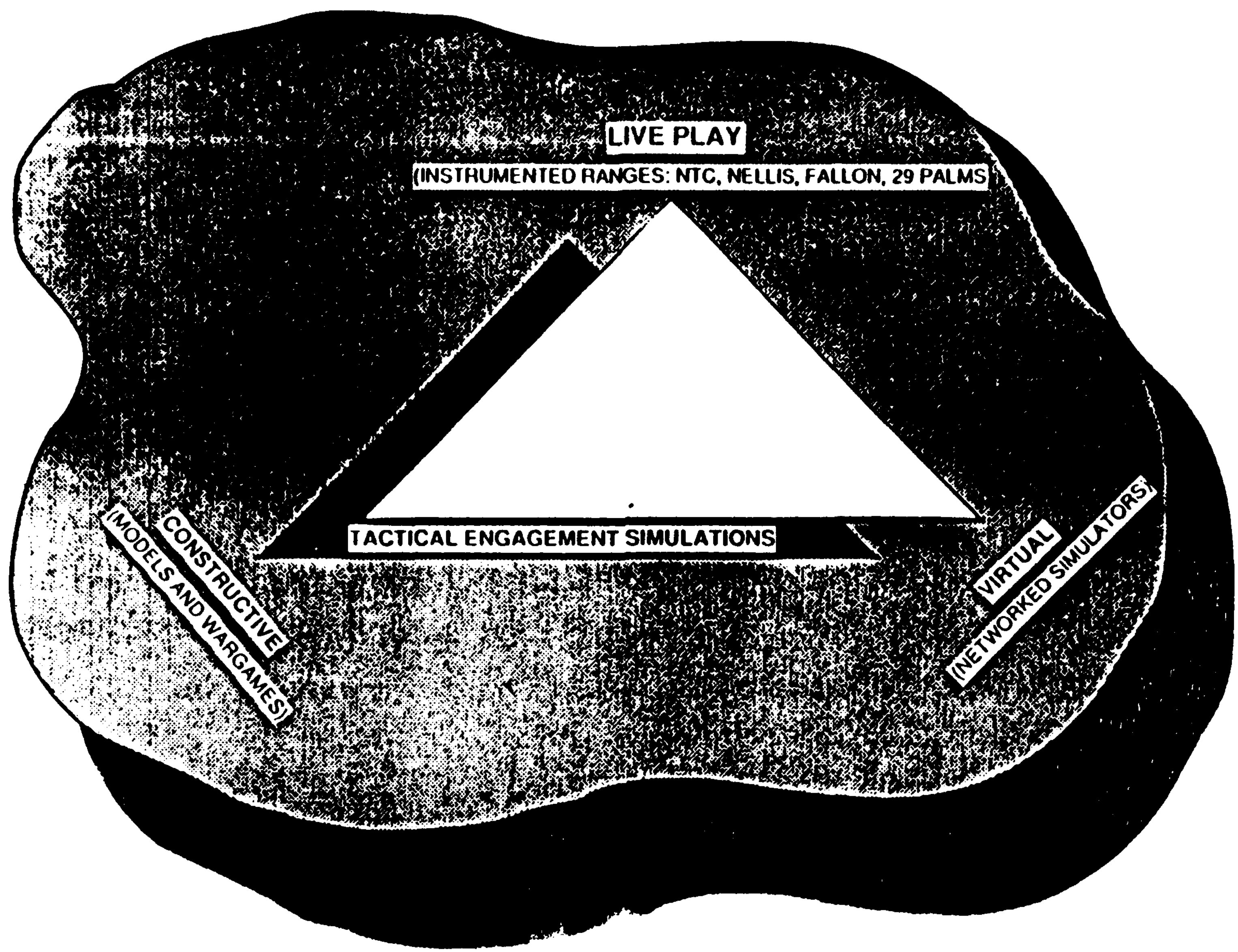
SYNTHETIC BATTLEFIELDS ON DEMAND

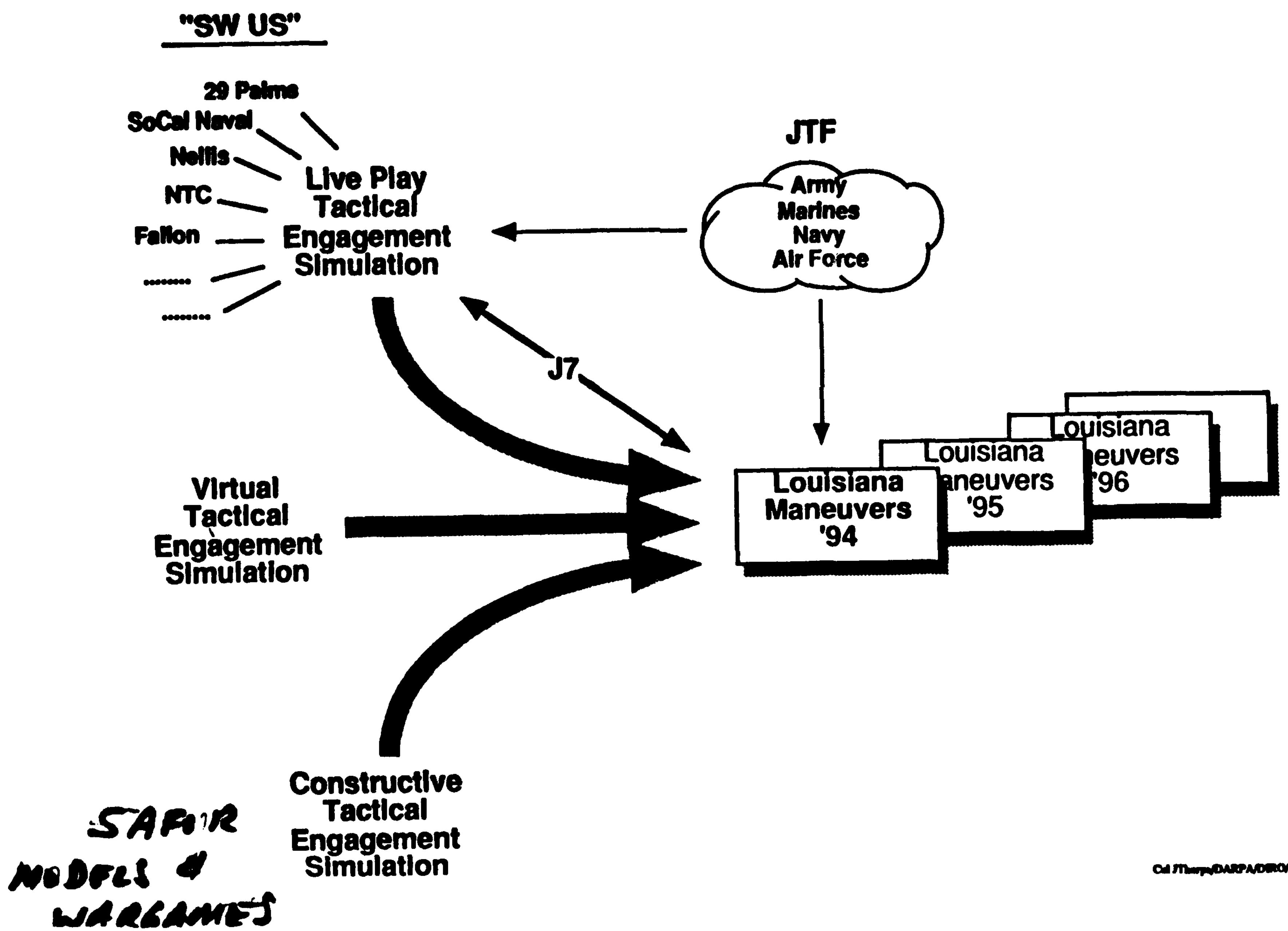
DARPA



SIMULATION TECHNOLOGY FOR THE SYNTHETIC BATTLEFIELD

DARPA Advanced Systems Technology Office

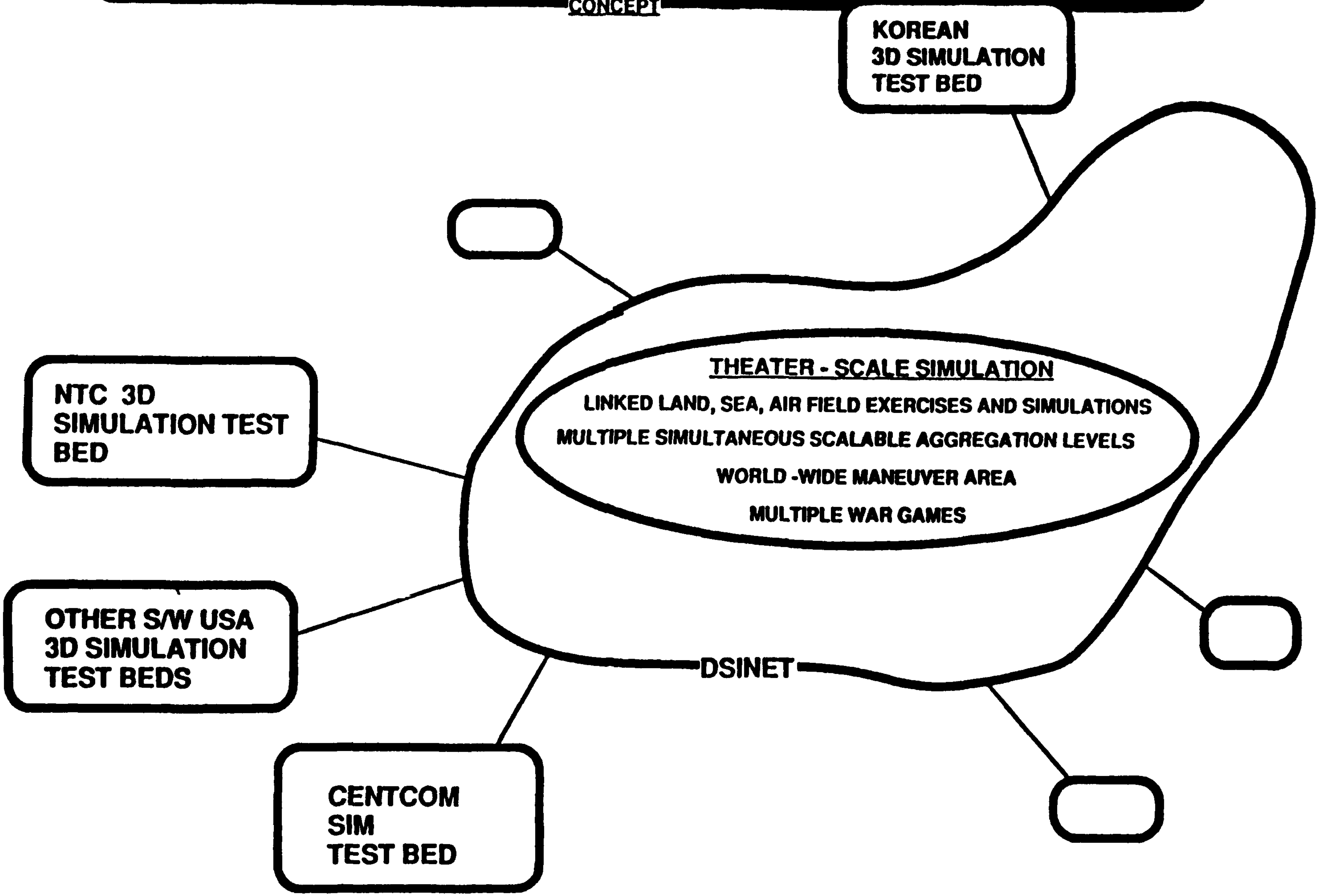




Col JThorpe/DARPA/DSRO/29Jun92

SYNTHETIC BATTLEFIELDS ON DEMAND

CONCEPT



TRAINING DESIGN & EVALUATION

Training Needs and Evaluation Issues

Identifying Over-and-Under Trained Tasks:
Ms. Michele Morales

Opportunities to Perform Trained Tasks
Dr. Mark Teachout

AN INVESTIGATION OF TRAINING EFFICIENCY

MICHELE M. MORALES
ARMSTRONG LABORATORY

MARCH 1992

TRAINING EFFICIENCY RESEARCH
OUTLINE

- RESEARCH OBJECTIVES
- 4 PHASES OF PROJECT
  - TRAINING CONTENT IDENTIFICATION
  - TRAINING EMPHASIS IDENTIFICATION
  - MATCHING TECHNIQUE APPLICATION
  - TASK PERFORMANCE LINKED WITH MATCHING TECHNIQUE
- CURRENT RESEARCH

RESEARCH OBJECTIVES

TO DEVELOP METHODOLOGIES TO EXAMINE:

1. TRAINING CONTENT VALIDITY
   - IS TRAINING CONTENT JOB RELEVANT?
2. TRAINING EFFICIENCY
   - ARE TASKS OVER OR UNDERTRAINED?

FOR THE AGE ABR COURSE

STEP 1

IDENTIFICATION OF TRAINING CONTENT DOMAIN

PURPOSE: IDENTIFY TRAINING CONTENT DOMAIN IN TERMS OF OSR TASK STATEMENTS

METHOD: SMEs LINKED OSR TO POI

SMEs LINKED TASKS TO INSTRUCTIONAL AREAS

INSTRUCTORS VERIFIED LINKS

OUTCOME: TRAINING DOMAIN IDENTIFIED AS CONSISTING OF 99 TASKS

STEP 2

IDENTIFICATION OF TRAINING EMPHASIS

PURPOSE: IDENTIFY EMPHASIS INSTRUCTORS PLACE ON EACH TASK TRAINED

METHOD: SURVEYS DEVELOPED FOR THE FIVE INSTRUCTIONAL AREAS

53 INSTRUCTORS SURVEYED

ESTIMATED TOTAL TIME DEVOTED TO EACH TASK

OUTCOME: TIME ESTIMATES FOR THE 99 TASKS TRAINED

STEP 3
APPLICATION OF THE MATCHING TECHNIQUE

PURPOSE: APPLY MATCHING TECHNIQUE TO AGE ABR COURSE

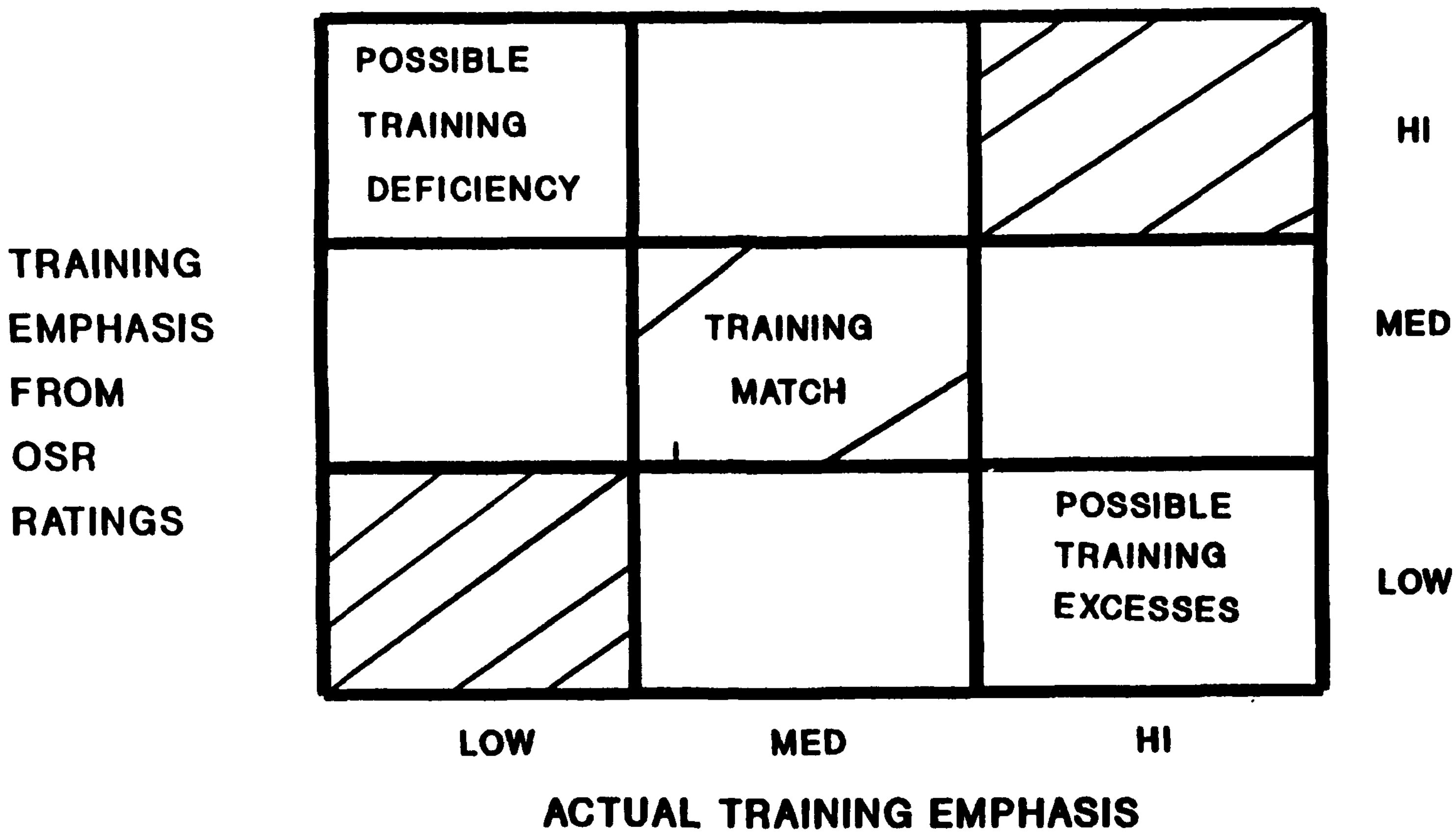
METHOD: COMPARE OSR EMPHASIS RATINGS TO INSTRUCTOR TIME ESTIMATES

RATINGS AND TIME ESTIMATES TRANSFORMED TO Z-SCORES

COMPUTER SOFTWARE DEVELOPED TO DISPLAY RESULTS

OUTCOMES: IDENTIFICATION OF POTENTIALLY OVER OR UNDERTRAINED TASKS

MATCHING TECHNIQUE TO EXAMINE TRAINING EFFICIENCY



TASK 441 ADJUST PNEUMATIC SYSTEM CLUTCHES

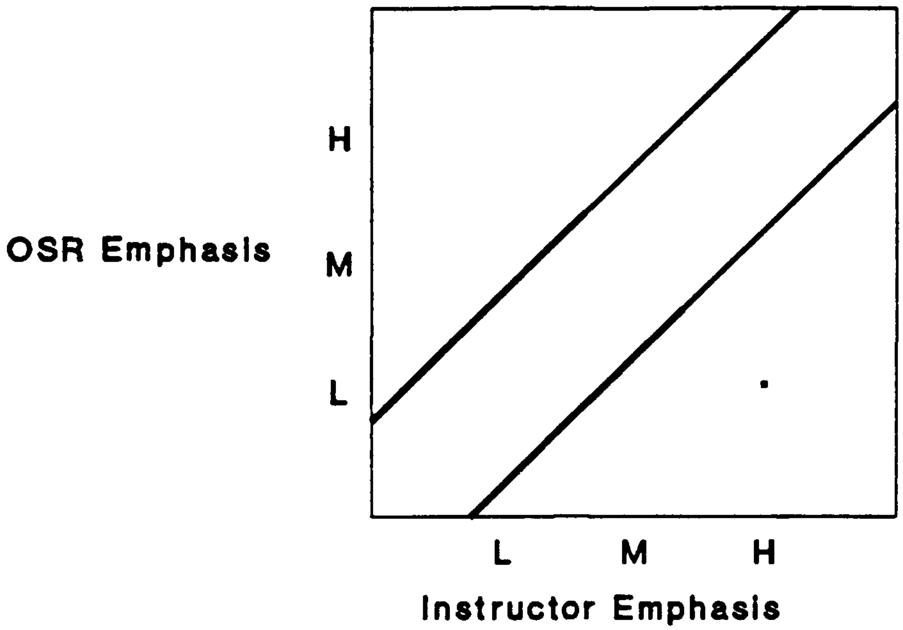


Figure 1a: Possible overtrained task

TASK 246 ADJUST GAS TURBINE ENGINE GOVERNORS

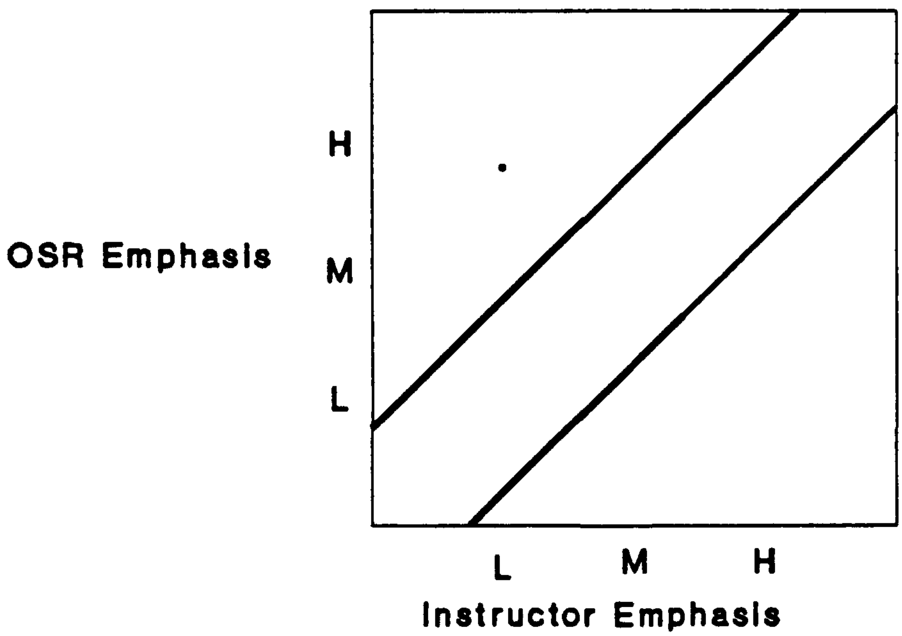


Figure 1b: Possible undertrained task

FIGURE 1. Examples of Possible Over and Undertrained Tasks.

TASK 264: ISOLATE ENGINE OR MOTOR MECH. MALF.

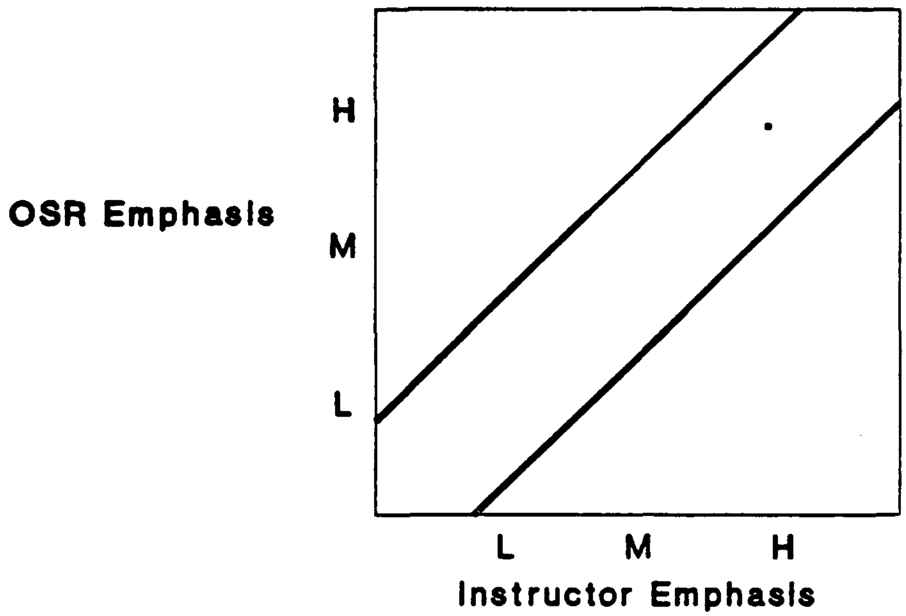


Figure 2a: Training hit, high emphasis

TASK 225: REMOVE OR INSTALL CANNON PLUG PARTS

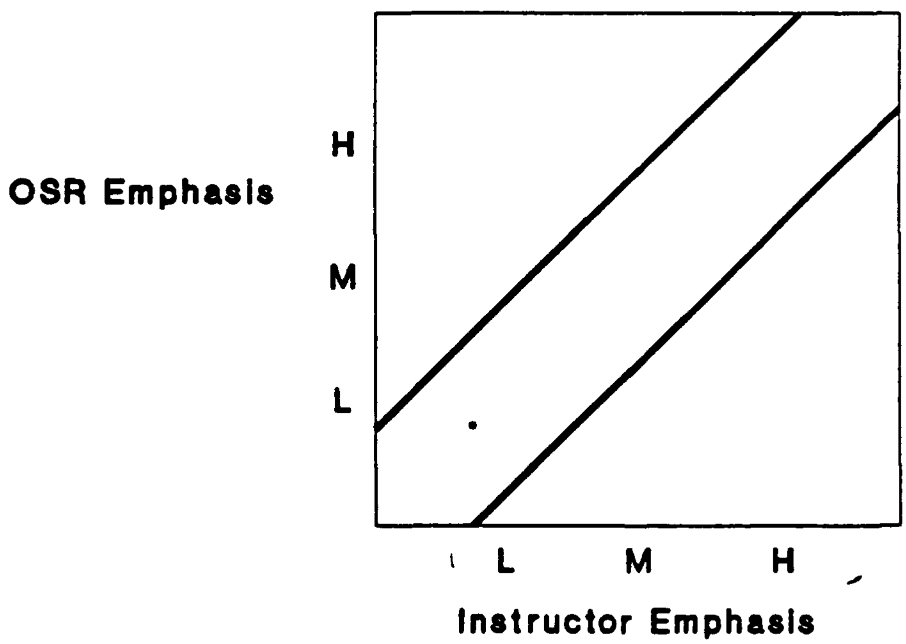


Figure 2b: Training hit, low emphasis

FIGURE 2. Examples of Tasks that are Training Hits.

STEP 4
LINKING MATCHING OUTCOMES & PERFORMANCE

PURPOSE: RELATE MATCHING OUTCOMES WITH TASK PERFORMANCE OF AGE AIRMEN

METHOD: DEVELOPMENT OF CONCEPTUAL MODEL

USE OF JPMS HANDS ON PERFORMANCE DATA FOR THE 11 TASKS TRAINED IN ABR COURSE

PERFORMANCE OF 52 OF 286 AIRMEN EXAMINED

WEIGHTED COMPOSITE SCORES ABOVE 5 CONSIDERED "PERFORMED WELL"

OUTCOMES: TASKS FOUND IN ALL SIX CELLS OF MODEL

RESULTS OF MATCHING TECHNIQUE	JOB PERFORMANCE LEVEL: Not Performed Well (Few People can Perform the Task Well)	JOB PERFORMANCE LEVEL: Performed Well (Most People can Perform the Task Well)
Training Excesses	Eliminate from Training and Find Other Options	Reduce or Maintain Training Emphasis
Training Deficiences	Increase Training Emphasis	Maintain Current Emphasis
Training Hits	Increase Training Emphasis or Find Other Options	Maintain Current Emphasis

FIGURE 3. Model of Matching Outcomes and Task Performance.

RESULTS OF MATCHING TECHNIQUE	JOB PERFORMANCE LEVEL: Not Performed Well (Few People can Perform the Task Well)	JOB PERFORMANCE LEVEL: Performed Well (Most People can Perform the Task Well)
Training Excesses	446	209
Training Deficiences	251 503	154 155 162
Training Hits	179 264	215 238

FIGURE 4. Results of Linking Matching Outcomes to Performance.

CURRENT RESEARCH

- GOAL OF TRAINING
- COLLECTION OF KNOWLEDGE AND PERFORMANCE DATA
- STUDY OF VARIABLES THAT INFLUENCE TRAINING

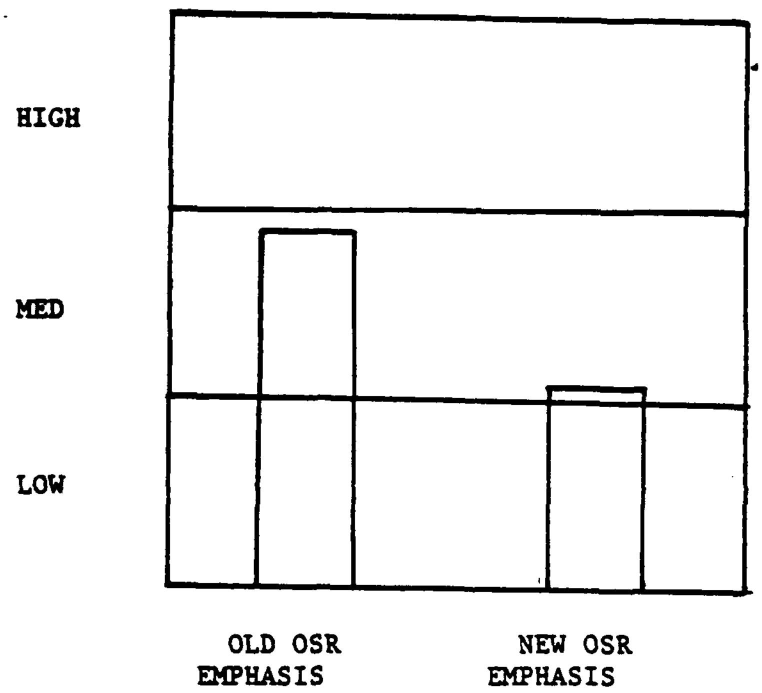
```
Cluster by equipment
Cluster by function
Rank order by % performing first term
Rank order by difficulty rating
Rank order by % performing 1st 12 mo.
Rank order by ATI
Return to main menu
```

Use the UP and DOWN ARROWS to highlight an option

Press RETURN to select the highlighted option

Screen 11

Task: 381 Isolate electrical circuitry malfunctions



Press any key to continue

Screen 17

FACTORS AFFECTING THE OPPORTUNITY TO PERFORM TRAINED TASKS

MARK S. TEACHOUT
23 MARCH 1992

PART I: For each task statement listed below, answer the following questions in the appropriate column. When completing these questions, only consider the **first twelve months since graduation from Chanute AFB** regardless of how long you have been at your present duty station.

1. In the first 12 months since completion of training at Chanute AFB, have you **PERFORMED** this task either with or without supervision? Completely fill in the circle "Y" if you have performed the task or fill in the circle "N" if you have not performed the task.

For every item that you answer yes, please answer the following two questions:

2. **WHEN** was the first time you performed the task? Fill in "Y" if you first performed the task in the first eight months after graduation. Otherwise, fill in the number corresponding to the month in which you first performed the task.

3. **HOW MANY TIMES** have you performed the task since graduating from Chanute AFB? Use the boxes to mark your answer. For example, if you have performed "Adjust contactor points" two times in the first twelve months since graduating from Chanute, you would write in the boxes 0 0 2

		PERFORMED? YES NO	WHEN? (MONTH)	HOW MANY OF TIMES?
1.	Fill out AFTO Forms 244	Y N	Y | 9 10 11 12	☐☐☐
2.	Make entries on AFTO Forms 350 (item processing tag)	Y N	Y | 9 10 11 12	☐☐☐
3.	Perform generator inspections	Y N	Y | 9 10 11 12	☐☐☐
4.	Measure resistance in electrical circuits	Y N	Y | 9 10 11 12	☐☐☐
5.	Perform electrical system operational checks	Y N	Y | 9 10 11 12	☐☐☐
6.	Solder electrical wiring	Y N	Y | 9 10 11 12	☐☐☐
7.	Splice electrical wiring.	Y N	Y | 9 10 11 12	☐☐☐
8.	Adjust engine fuel system components	Y N	Y | 9 10 11 12	☐☐☐
9.	Isolate engine, motor, or generator mechanical malfunctions	Y N	Y | 9 10 11 12	☐☐☐
10.	Perform compression tests	Y N	Y | 9 10 11 12	☐☐☐
11.	Perform engine, motor, or generator operational checks	Y N	Y | 9 10 11 12	☐☐☐
12.	Remove or install AGE tire, tube, or wheel assemblies	Y N	Y | 9 10 11 12	☐☐☐
13.	Perform air conditioner visual or service inspections	Y N	Y | 9 10 11 12	☐☐☐
14.	Perform hydraulic test stand service inspections	Y N	Y | 9 10 11 12	☐☐☐
15.	Perform hydraulic test stand periodic inspections	Y N	Y | 9 10 11 12	☐☐☐
16.	Clean motor or generator armatures	Y N	Y | 9 10 11 12	☐☐☐
17.	Charge refrigerant systems	Y N	Y | 9 10 11 12	☐☐☐
18.	Perform air conditioner leakage tests	Y N	Y | 9 10 11 12	☐☐☐
19.	Perform air conditioner operational checks	Y N	Y | 9 10 11 12	☐☐☐
20.	Purge refrigerant systems	Y N	Y | 9 10 11 12	☐☐☐
21.	Adjust hydraulic high pressure system components	Y N	Y | 9 10 11 12	☐☐☐
22.	Isolate hydraulic system malfunctions	Y N	Y | 9 10 11 12	☐☐☐
23.	Perform hydraulic system operational checks	Y N	Y | 9 10 11 12	☐☐☐
24.	Pack wheel bearings	Y N	Y | 9 10 11 12	☐☐☐
25.	Perform load bank inspections	Y N	Y | 9 10 11 12	☐☐☐
26.	Remove or install engine fan belts	Y N	Y | 9 10 11 12	☐☐☐
27.	Perform generator periodic inspections	Y N	Y | 9 10 11 12	☐☐☐
28.	Perform gas turbine compressor periodic inspections	Y N	Y | 9 10 11 12	☐☐☐
29.	Adjust turbine engine bleed air systems	Y N	Y | 9 10 11 12	☐☐☐
30.	Adjust turbine engine fuel systems	Y N	Y | 9 10 11 12	☐☐☐
31.	Load test generator sets	Y N	Y | 9 10 11 12	☐☐☐
32.	Perform air compressor periodic inspections	Y N	Y | 9 10 11 12	☐☐☐
33.	Isolate heating system malfunctions	Y N	Y | 9 10 11 12	☐☐☐
34.	Perform heating system operational checks	Y N	Y | 9 10 11 12	☐☐☐
35.	Isolate air compressor system malfunctions	Y N	Y | 9 10 11 12	☐☐☐
36.	Remove or install air compressor filtering system components.	Y N	Y | 9 10 11 12	☐☐☐
37.	Remove or install fuel lines or fittings other than diesel	Y N	Y | 9 10 11 12	☐☐☐
38.	Remove or install hydraulic lines or fittings	Y N	Y | 9 10 11 12	☐☐☐
39.	Research TO's, charts, or diagrams for AGE enclosures, chassis, or drives	Y N	Y | 9 10 11 12	☐☐☐
40.	Inspect vehicles for safety of operation	Y N	Y | 9 10 11 12	☐☐☐

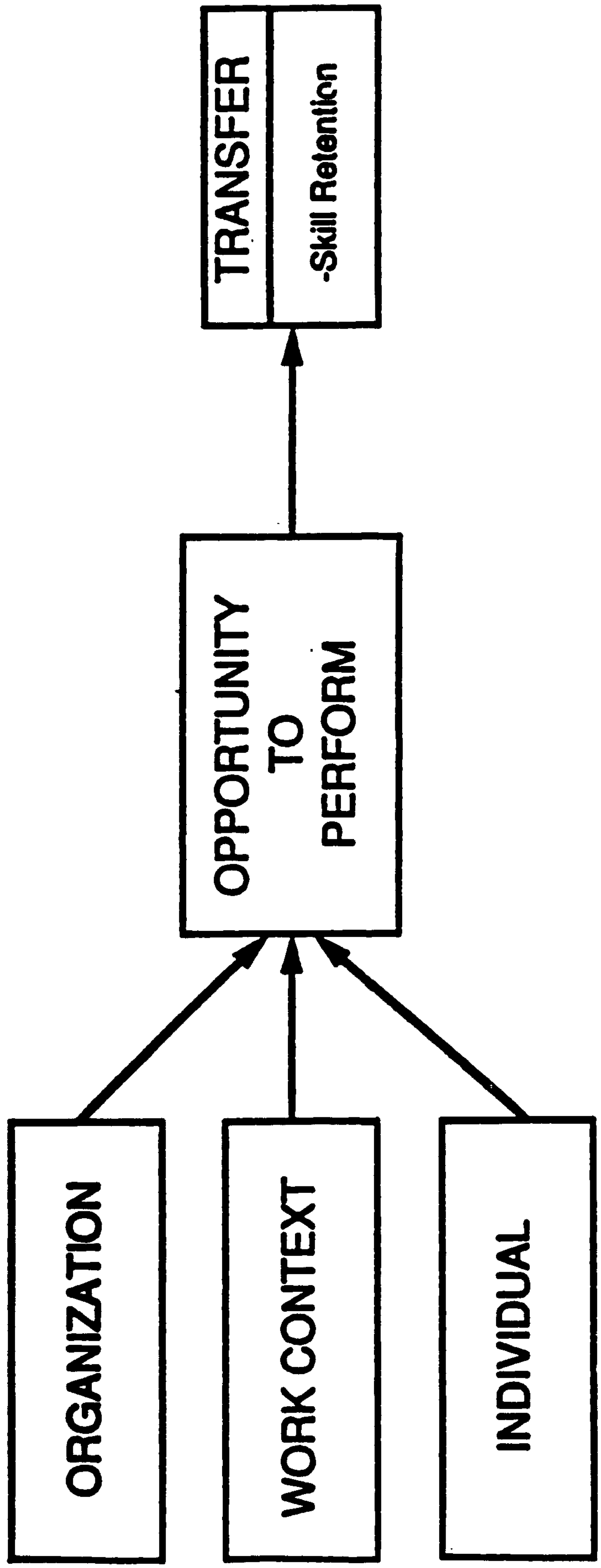
% PERFORMING TASK BY MONTH
After 4 Months

TASK #	MONTH 1	MONTH 2	MONTH 3	MONTH 4	TOTAL
1	62.4	27.5	4.2	.5	**94.6**
2	47.6	27.8	11.8	3.2	**90.4**
3	22.2	33.3	16.4	4.2	**76.1**
4	17.5	35.4	12.7	5.3	**70.9**
5	29.8	29.8	17.6	3.7	**80.9**
6	13.6	19.4	17.3	4.7	**55.0**
7	24.1	35.6	16.2	2.6	**78.5**
8	8.9	25.8	20.0	4.7	**59.4**
9	12.2	21.7	20.1	5.8	**59.8**
10	1.6	5.3	7.4	1.6	**15.9**
11	41.0	37.8	12.8	2.7	**94.3**
12	21.6	35.8	24.2	2.6	**84.2**
13	7.4	22.6	12.6	11.6	**54.2**
14	3.7	12.6	15.3	6.8	**38.4**
15	2.6	5.2	9.9	3.7	**21.4**
16*	4.2	12.1	7.9	3.2	**27.4**
17	0.0	4.7	3.2	1.6	**9.5**
18	0.0	2.6	3.7	1.0	**7.3**
19	5.2	18.8	16.8	5.2	**46.0**
20	0.0	2.6	3.1	0.0	**5.7**

Times Performing Task

After 4 Months

TASK	MEAN	RANGE	SD
1	20.8	1-125	22.7
2	10.1	1-75	10.1
3	7.6	1-75	10.6
4	5.3	1-25	5.3
5	12.0	1-75	12.9
6	3.3	1-20	3.4
7	8.7	1-50	9.7
8	4.2	1-15	3.4
9	5.6	1-25	4.8
10	3.3	1-20	4.0
11	20.3	1-104	20.8
12	6.8	1-30	6.5
13	6.0	1-35	7.3
14	4.9	1-30	5.8
15	2.3	1-8	2.1
16*	3.8	1-20	3.9
17	3.8	1-15	4.4
18	2.5	1-10	2.5
19	6.0	1-35	6.9
20	2.9	1-10	3.0


TRANSFER
-Skill Retention
OPPORTUNITY
TO
PERFORM
ORGANIZATION
WORK CONTEXT
INDIVIDUAL

OPPORTUNITY TO PERFORM CONSTRUCT

DIMENSION	DEFINITION
Breadth	# of Tasks
Activity Level	# Times
Task Type	Difficulty/Criticality

METHOD

<u>TRAINING COURSE</u>

Aerospace Ground Equipment

18 Weeks

99 Tasks Taught

<u>SAMPLE</u>

180 Recent Graduates

34 Tasks Sampled

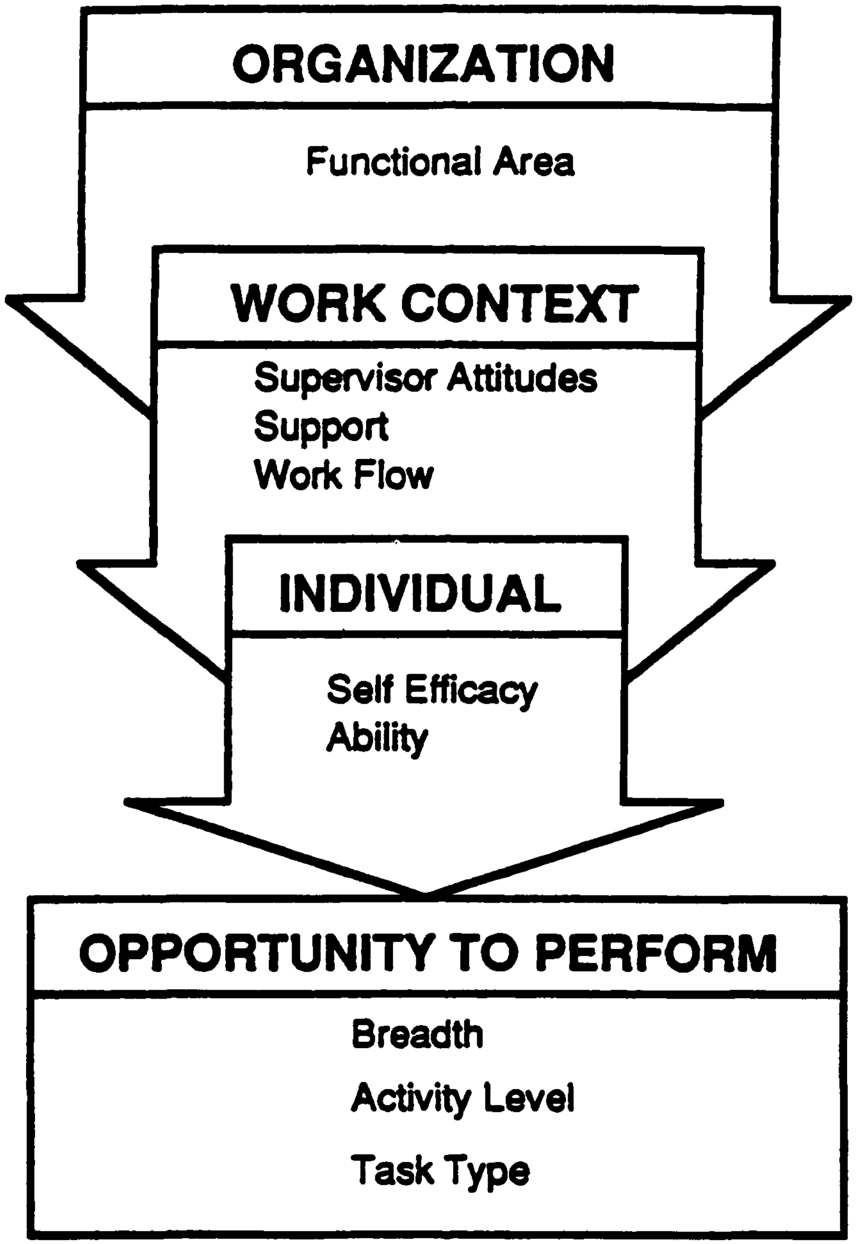
<u>DATA COLLECTION</u>

Survey Methodology

Measures gathered 4 months after training

MEASURES

SUPERVISOR	AIRMAN	OTHER
Attitudes Toward Airman	Opportunity to Perform	MAJCOM
Work Flow	Support	Ability (ASVAB)
	Self Efficacy	


ORGANIZATION
Functional Area
WORK CONTEXT
Supervisor Attitudes
Support
Work Flow
INDIVIDUAL
Self Efficacy
Ability
OPPORTUNITY TO PERFORM
Breadth
Activity Level
Task Type

Hierarchical Block Regression Results

For Breadth

STEP	VARIABLES	R^2	ΔR^2
1	MAJCOM	.04	.04
2	Sup Attitudes[a] Support Work Flow	.10*	.06*
3	Self Efficacy[a] Ability (AFQT)	.20*	.10*

NOTE: * $p<.05$

[a] Beta for this variable was significant ($P<.05$) at this step

Hierarchical Block Regression Results

For Activity Level

STEP	VARIABLES	R^2	ΔR^2
1	MAJCOM [a]	.07*	.07*
2	Sup Attitudes Support Work Flow	.09*	.02
3	Self Efficacy Ability (AFQT) [a]	.13*	.04*

NOTE: * $p<.05$

[a] Beta for this variable was significant ($P<.05$) at this step

Hierarchical Block Regression Results

For Task Type

STEP	VARIABLES	R^2	ΔR^2
1	MAJCOM	.03	.03
2	Sup Attitudes[a] Support[a] Work Flow	.50*	.47*
3	Self Efficacy[a] Ability (AFQT)	.55*	.05*

NOTE: * p<.05

[a] Beta for this variable was significant (P<.05) at this step

Findings

- Opportunity to perform is a multidimensional construct

- There are individual differences in opportunities to perform trained tasks

- These differences are predictable

SUBGROUP SESSION II

ADVANCED TRAINING TECHNOLOGY

Visual Learning in Virtual Environment:
Dr. J. Psotka

Summary and Conclusions of Virtual Reality in Training Research in the Services or "What are the Research Issues in the use of Virtual Reality in Training?"

Visual Communication in Multi-Media Virtual Realities.

This basic research project in visual communication examines how visual knowledge should be structured to take full advantage of advanced computer environments for training, especially hypertext and virtual reality. A Visual AirCraft Recognition (VACR)Training hypertext has been built and tested. Virtual Reality workstations have been explored and will be used for future experiments. A theory of visual concept learning is under development.

6.1 RESEARCH

Our first experiments examined the interface, architecture, and training strategy issues for combining images and text in multimedia systems. An Army Field Manual (FM 44-30) was completely digitized, and redesigned to take advantage of several powerful hypertext features: search, browsing, "hot" words or buttons, apparent motion, and colored contrasts. A series of experiments determined the training advantages of these features. These results were integrated into a theoretical framework that combined "ecological perception" with "apparent motion" as a basis for visual concept learning. The theory is continuing to be refined and tested in ongoing work.

The hypertext and digitized images are being transferred from our experimental multimedia platform to a state-of-the-art Virtual Reality Platform for research. This work will examine the value of virtual "immersion" into a 3-D environment for memory of spatial orientation, over 2-D spatial interfaces. In addition, the Virtual Reality workstation will allow us to extend our theoretical framework to begin to analyze the comparative strengths of speech communication versus visual communication in the exchange of shared mental models among crew and group members. Interactions between people and simulated crew members will use detailed models of animated agents and faces developed at the Army Center for AI at the University of Pennsylvania.

THEORY

Basic theories about visual communication need to be developed in detail if the rapid progress in computer technologies is to be fully leveraged in future Army training. Recent synthetic reality and hypermedia computer technologies, combined with Artificial Intelligence (AI) knowledge representation techniques, offer unprecedented opportunities for digitizing, displaying, transforming, and transmitting pictures as easily as words and sentences.

POTENTIAL MILITARY RELEVANCE

The Army is increasingly turning to large scale simulator networking for cost effective training of warfighting skills. This research advances several core technologies that will be transferred to 6.2 research in AISTA, PM-TRADE Field Unit, and Ft. Bliss Field Unit. The VACR training hypertext is being transferred to Ft. Bliss currently. Future work will have direct bearing on distributed simulator design for "popped hatch" tank simulators, and effective crew communication and spatial navigation training.

ARI POC: Dr. Joseph Psotka, AV 284-5540; Comm (703) 274-5540.

Visual Concept Training Basic Research

To Toc

Research Problem

What are the best

- Technological opportunities for Visual Communication?
- Interfaces to complex visual knowledge spaces?
- Training designs in advanced technology environments?

Research Approach

Hypothesis: Use Ecological Perception to Structure Knowledge

- Digitize a multimedia HyperBook for training
- Conduct experiments to determine principles of training design in multimedia environments

Visual Concept Training Basic Research

To Toc

Technological Opportunity

- o Visual Communication
  - o Hypertext and Multimedia
  - o AI and Semantic Networks
  - o CyberSpace

Army Relevance

- o Training and Command/Control
  - o Protect SHORAD Lethality
  - o VACR -- Visual AirCraft Recognitior
  - o HQDA -- FM 44-30

Visual Concept Training Basic Research

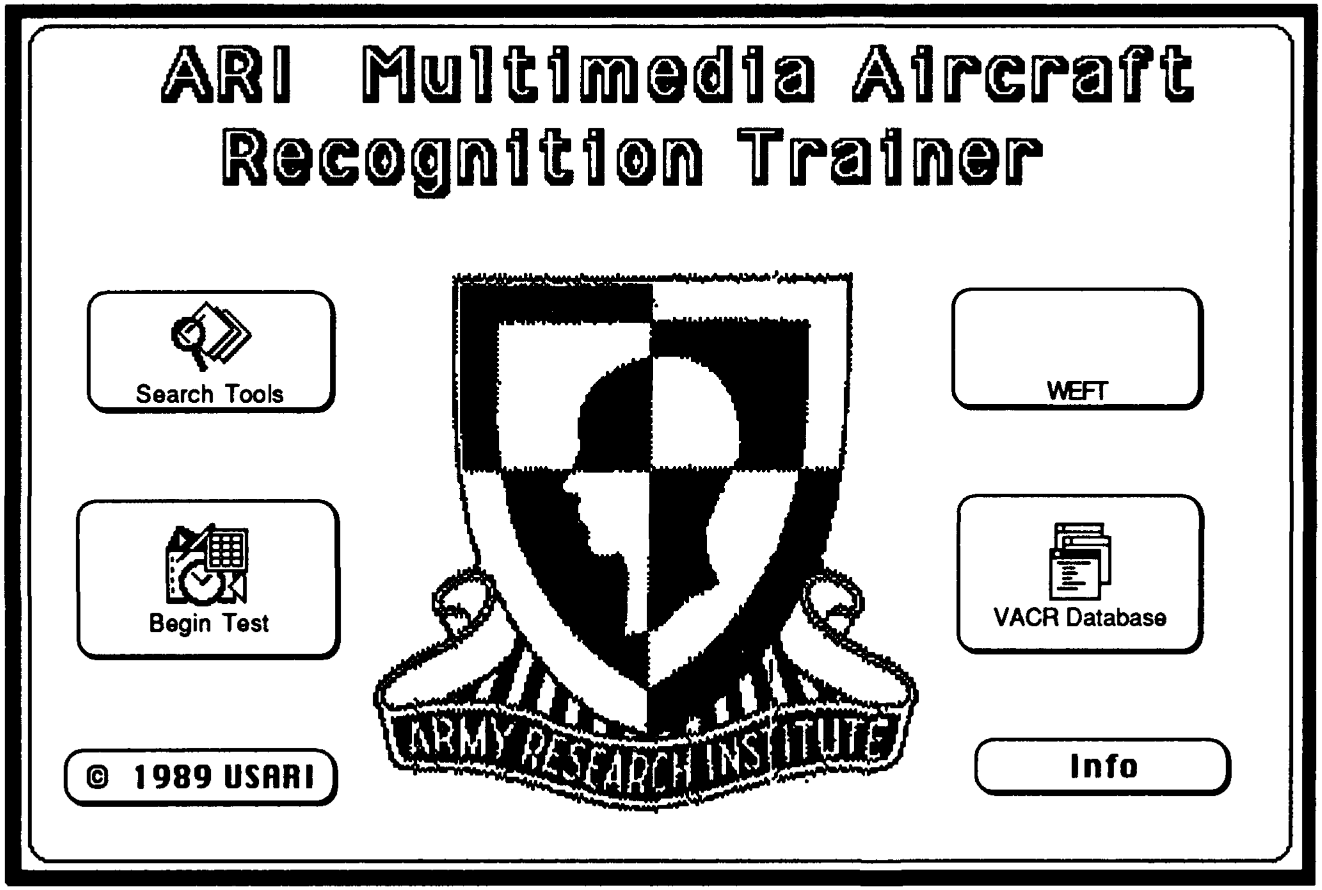
To Toc

Expected Outcomes

- o Exploration of Technological Possibilities
- o Cognitive Theory of Visual Concept Training
- o Experiments Verifying Principles of Hypertext Desigr for Combining Text and Image Media in Training

Research Accomplishments

- o FM 44-30 Digitized Hypertext
- o Technologies for Comparison and Contrast of Visual
- o CyberSpace Interface to AirPlane Pictorial Browser



Basic Research Briefing

☐ Table of Contents

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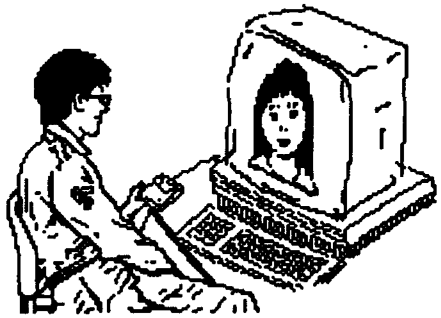
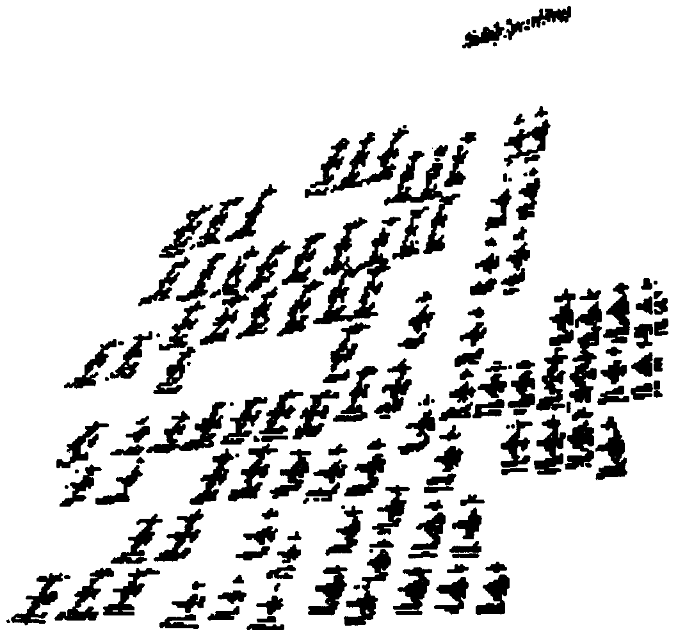
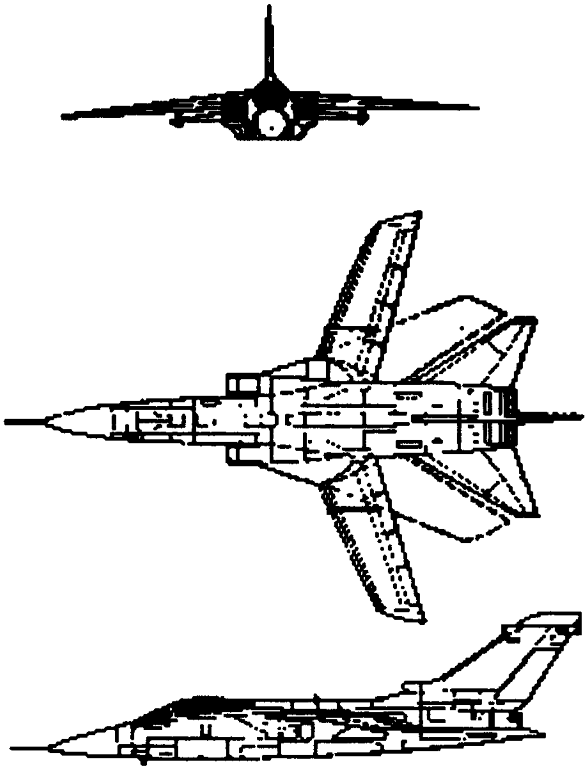






EXAMPLE

- ○ MILLARD FILLMORE
- ○ JOHN ADAMS
- ○ TORNADO
- ○ GEORGE MASON

FIRST EXPERIMENT

To Toc

FM 44-30 VERSUS HYPERBOOK

Learn names of 20 planes in half an hour

Unpaired t-Test X_1 : Condition Y_1 : PosTest

DF:	Unpaired t Value:	Prob. (1-tail):
8	-3.772	.0028

Group:	Count:	Mean:	Std. Dev.:	Std. Error:
Book	5	12.8	2.168	.97
HyperCard	5	17	1.225	.548

2 Standard Deviation effect with only 10 Subjects

12.8 / 20 17 / 20 Correct

SECOND EXPERIMENT

To Toc

FM 44-30 VERSUS HYPERBOOK

TEST NOT JUST ON OUTLINES, BUT ON DIFFERENT PICTURES AND MODELS

RESULTS

- o HyperBook still superior on tests
- o Much more examination of HyperBook
  - o Similar Planes, ContraPict, WEFT

Third EXPERIMENT

To Toc

FM 44-30 VERSUS HYPERBOOK

TEST AGAINST SIMILAR PLANES
TRANSFER TEST AGAINST NEW PICTURES
TWENTY PLANES IN ONE HOUR

RESULTS

- HyperBook superior on transfer test
- Individual examination of HyperBook
    - Similar Planes, ContraPict, WEFT
- Many more complaints from FM studiers

Aircraft Name

DIRECTIONS:

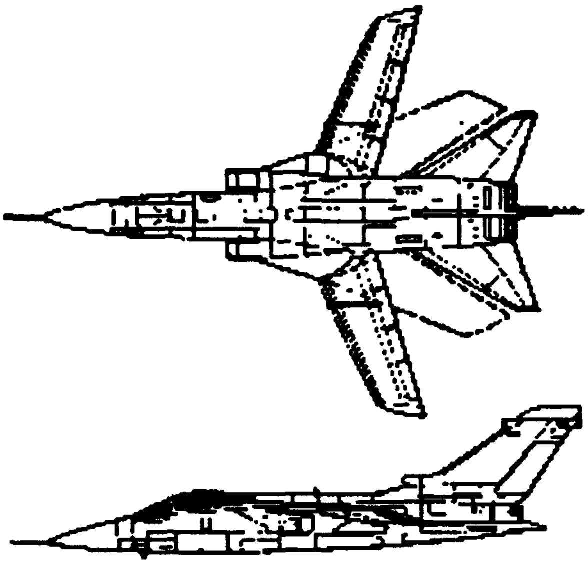
Click on the name of any plane to go to the card with information about that plane.

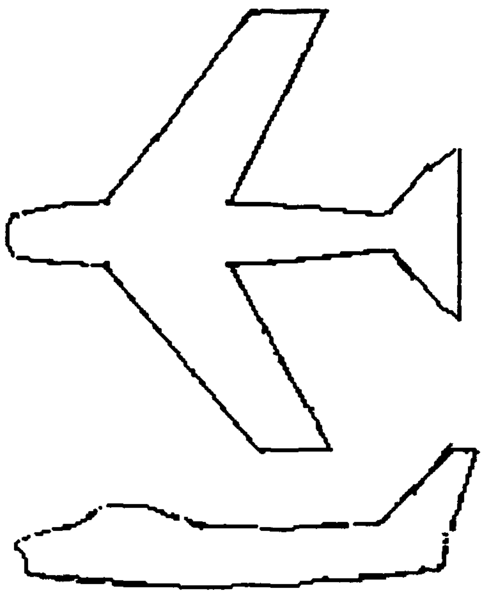
JAGUAR
AV-8 HARRIER
KING AIR U-21
HAWK
DRAKEN
F-15 EAGLE
AN-24 COKE, AN-26 CURL
YAK-36 FORGER
U-8F SEMINOLE,QUEEN AIR
TU-26 BACKFIRE
C-141B STARLIFTER
HUNTER
A-6 INTRUDER
F-4 PHANTOM
MIG-25 FOXBAT
MIRAGE-III/5
C-5A GALAXY
B-1B
An-32 CLINE
KFIR C-2
TORNADO

Main Menu

EXAMPLE

- MILLARD FILLMORE
- JOHN ADAMS
- TORNADO
- GEORGE MASON



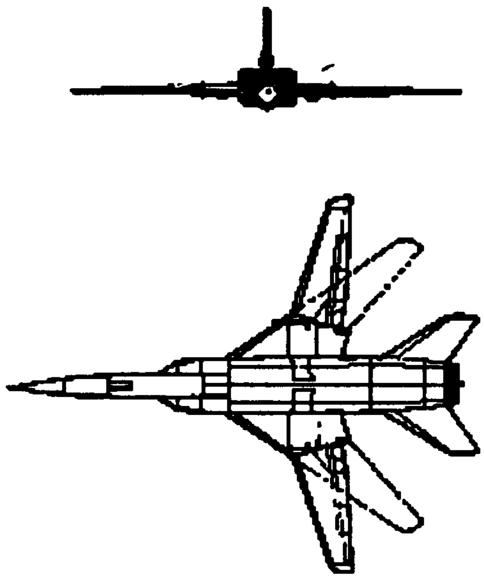


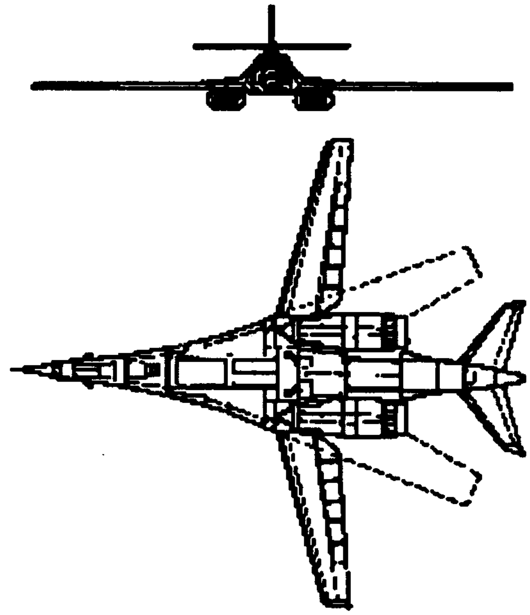
○ TU-16 BADGER ○

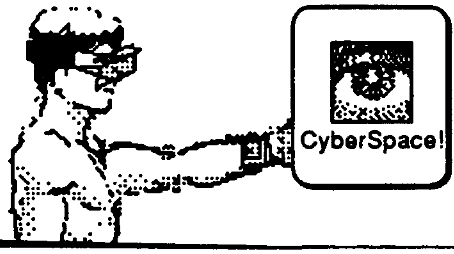
○ TU-26 BACKFIRE ○

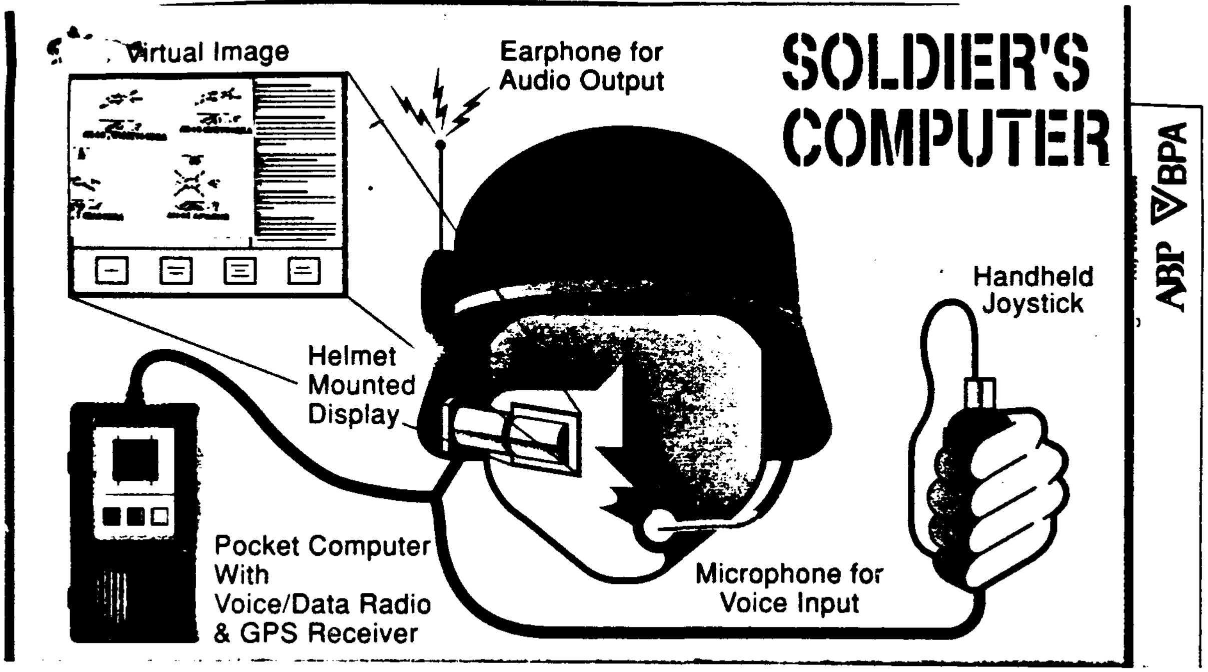
○ B-52 ○

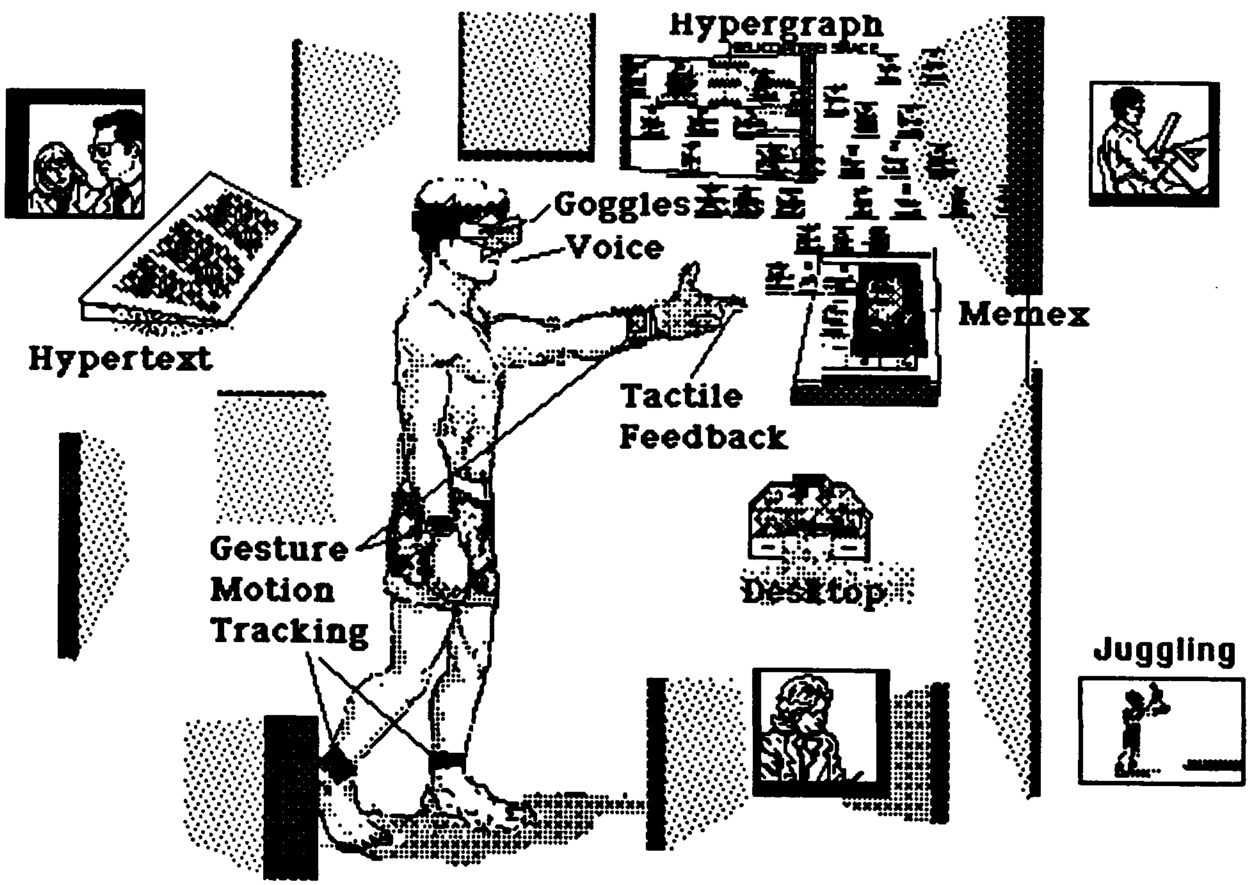
○ JAGUAR ○



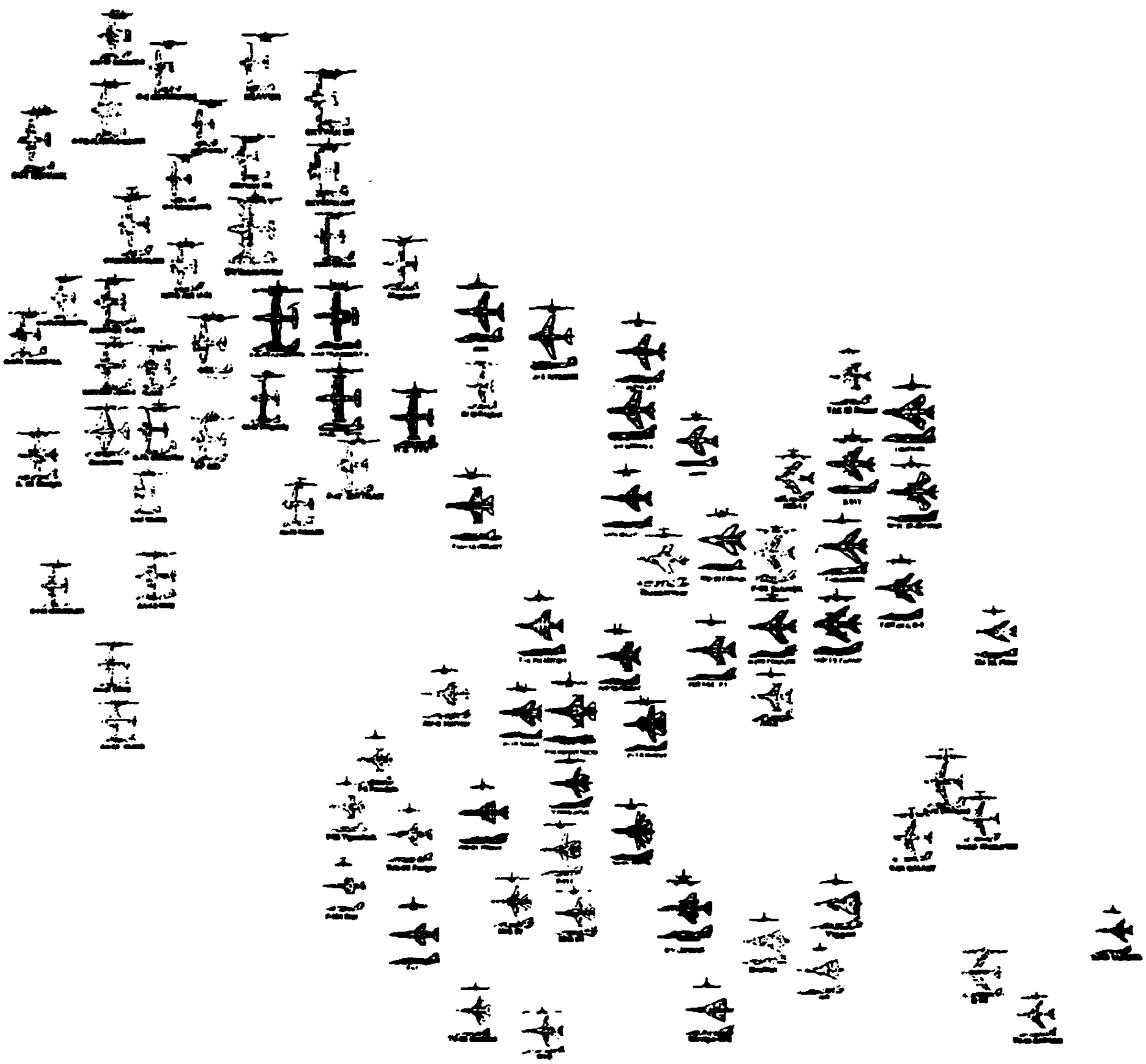



CyberSpace!

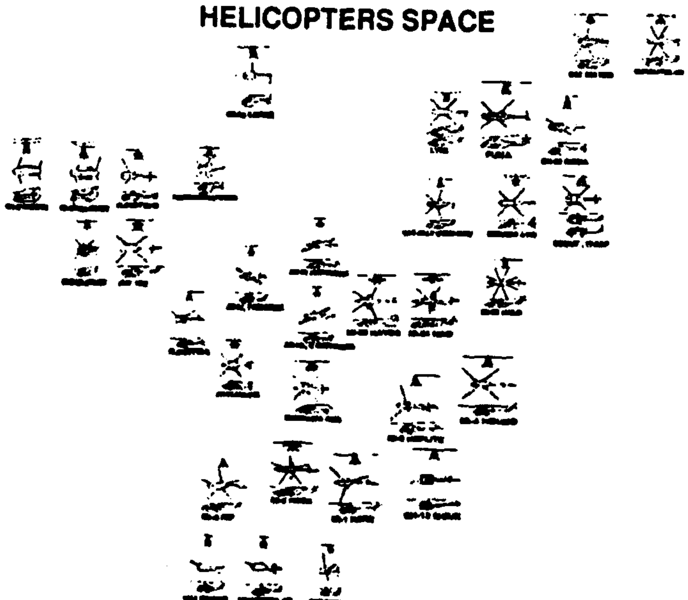

SOLDIER'S COMPUTER
Virtual Image
Earphone for Audio Output
Handheld Joystick
Helmet Mounted Display
Pocket Computer With Voice/Data Radio & GPS Receiver
Microphone for Voice Input


Hypergraph
Goggles
Voice
Memex
Hypertext
Tactile Feedback
Gesture Motion Tracking
Desktop
Juggling

Similarity Space of Planes



HELICOPTERS SPACE



Third EXPERIMENT

To Toc

FM 44-30 VERSUS HYPERBOOK

Learn names of 20 planes in an hour

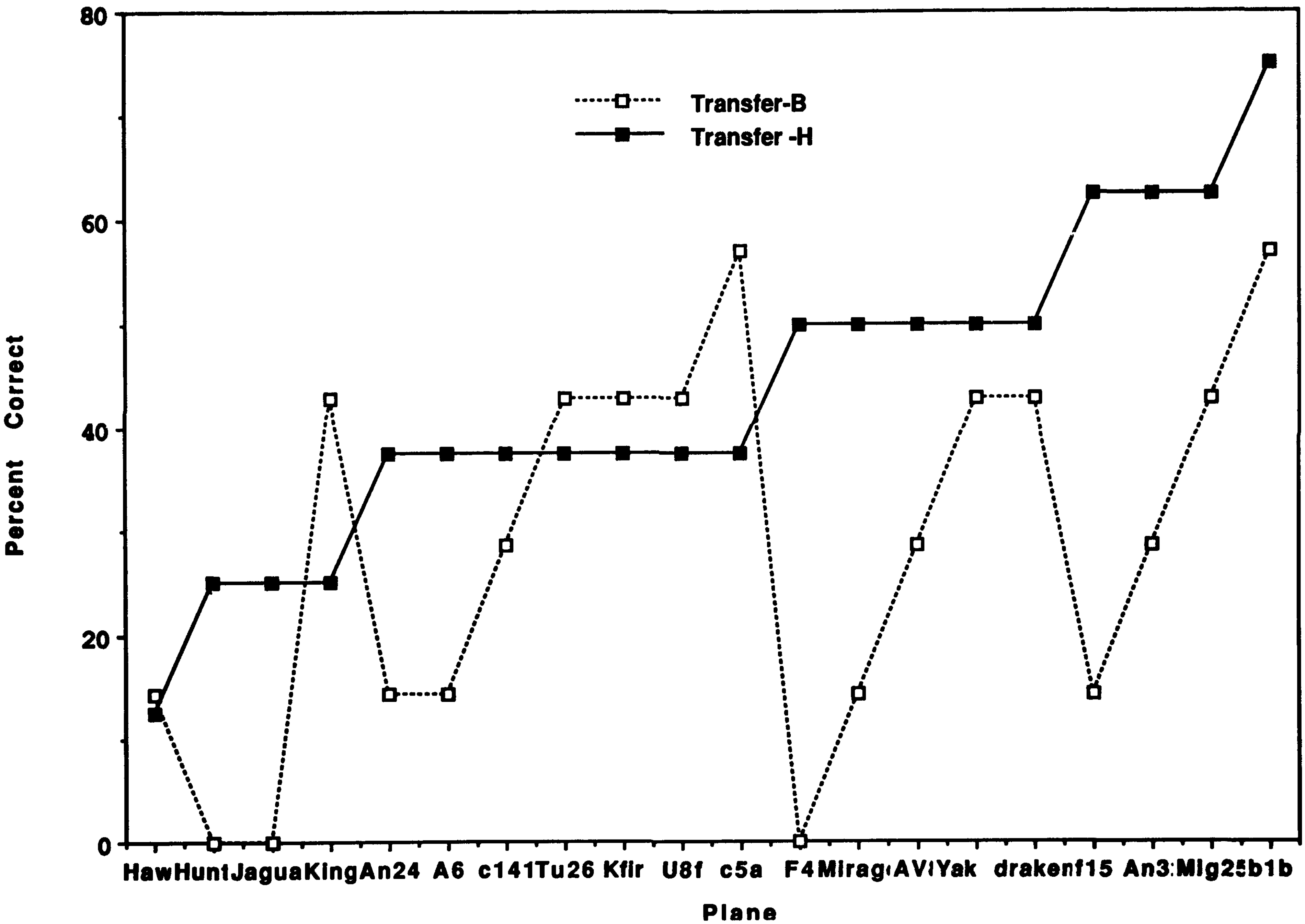
	PreTest	PostTest	TransferTest
HyperBook (N=8)	13.8*	55.0*	41.6**
Book (N=7)	14.6*	48.2*	30.0**

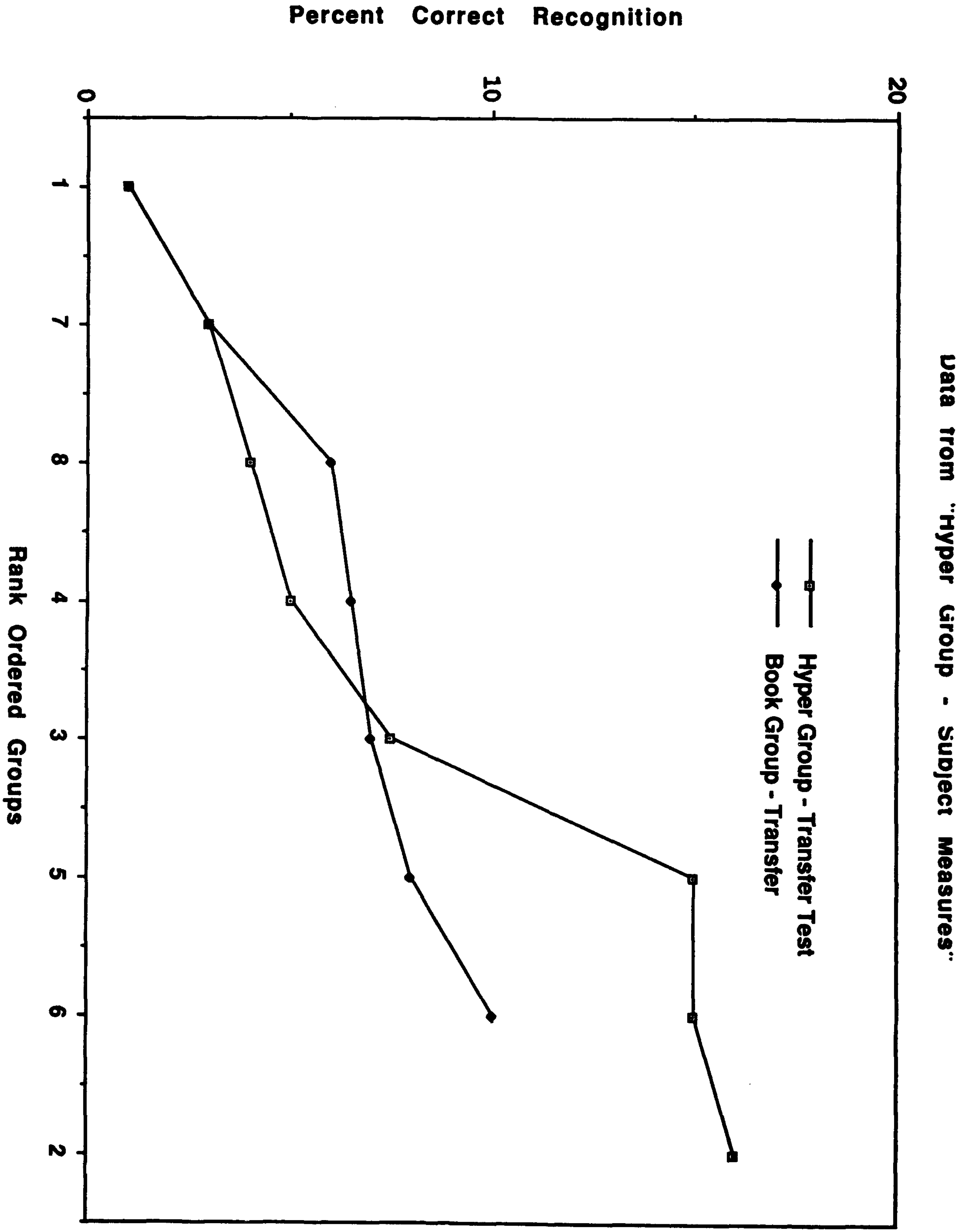
** p.<.05 (sign test)

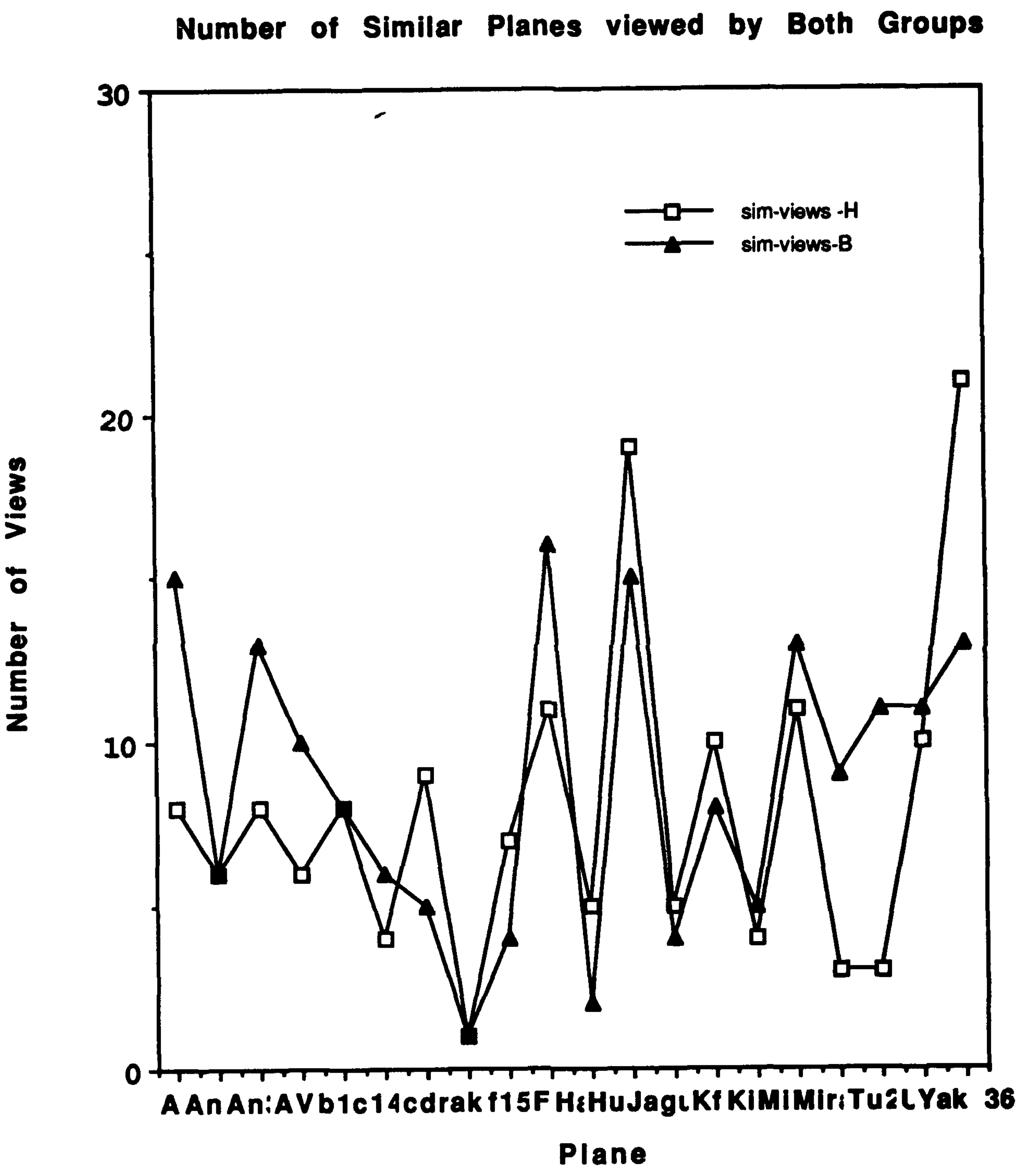
* not sig.

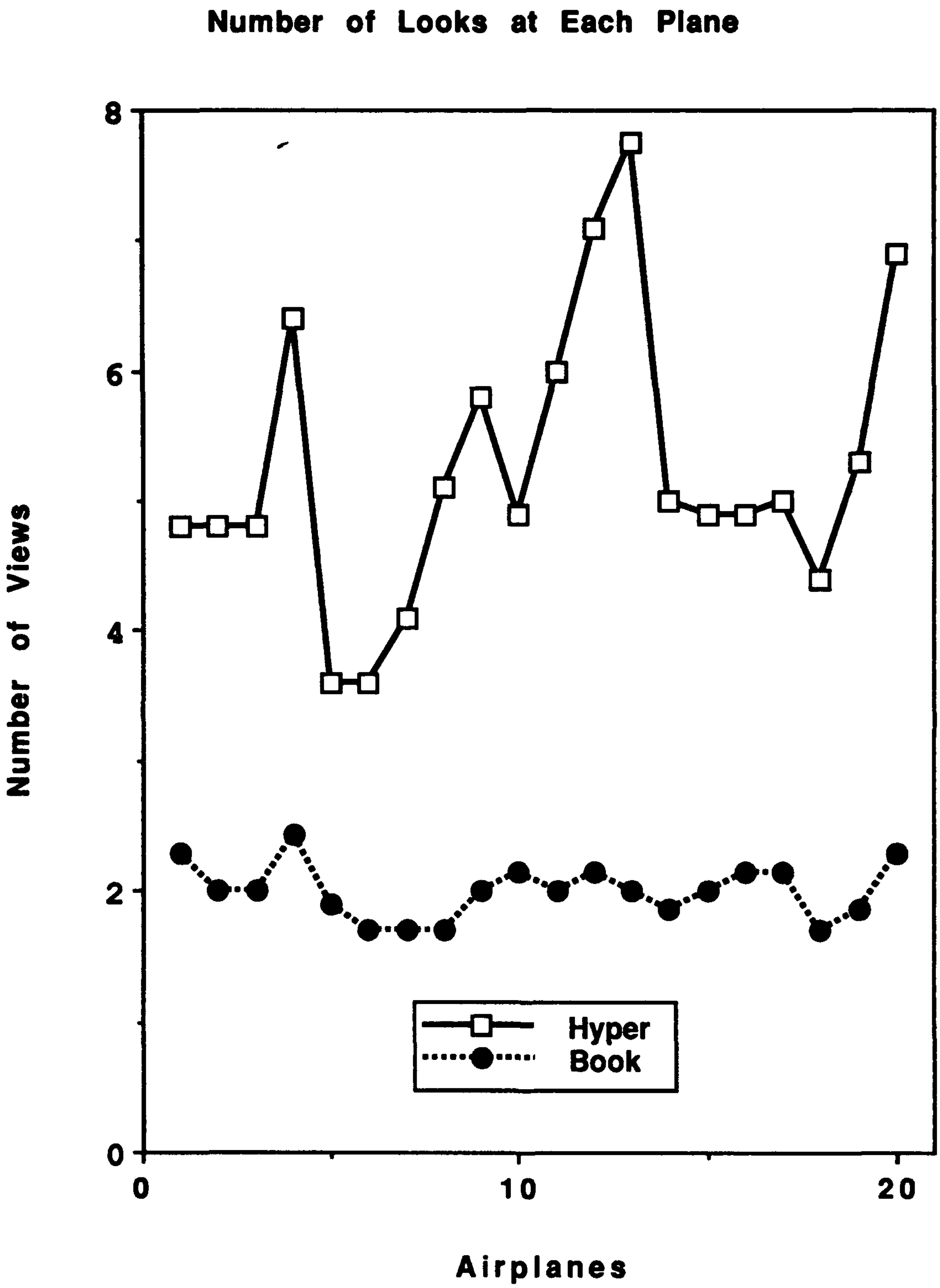
Percent correct recognition after 1 hour study.

Percent recognition for Book and Hyper Groups on Transfer Test with New Pictures

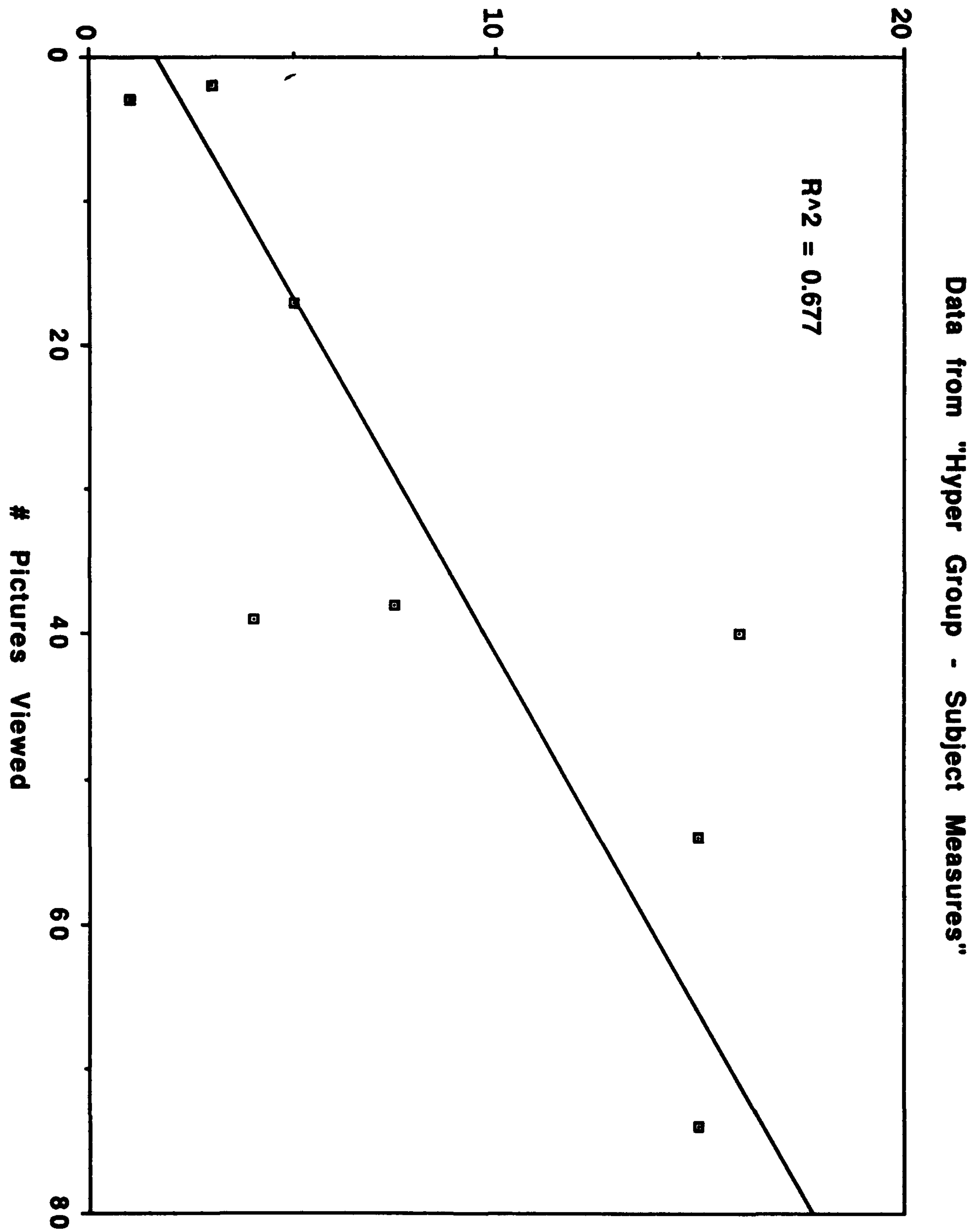


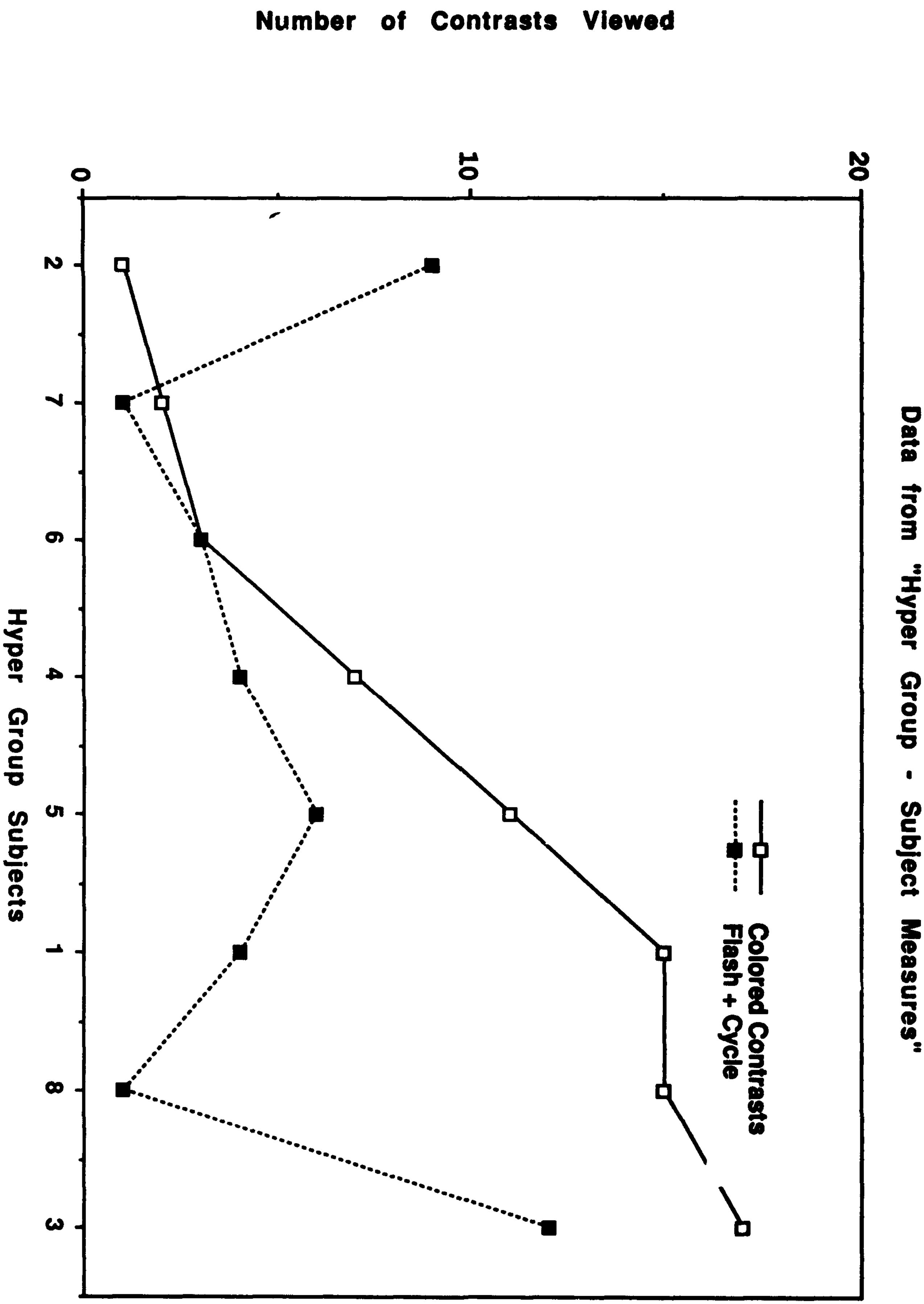

Data from "Hyper Group - Subject Measures"
Percent Correct Recognition
0
10
20
Rank Ordered Groups
1
7
8
4
3
5
6
2
Hyper Group - Transfer Test
Book Group - Transfer

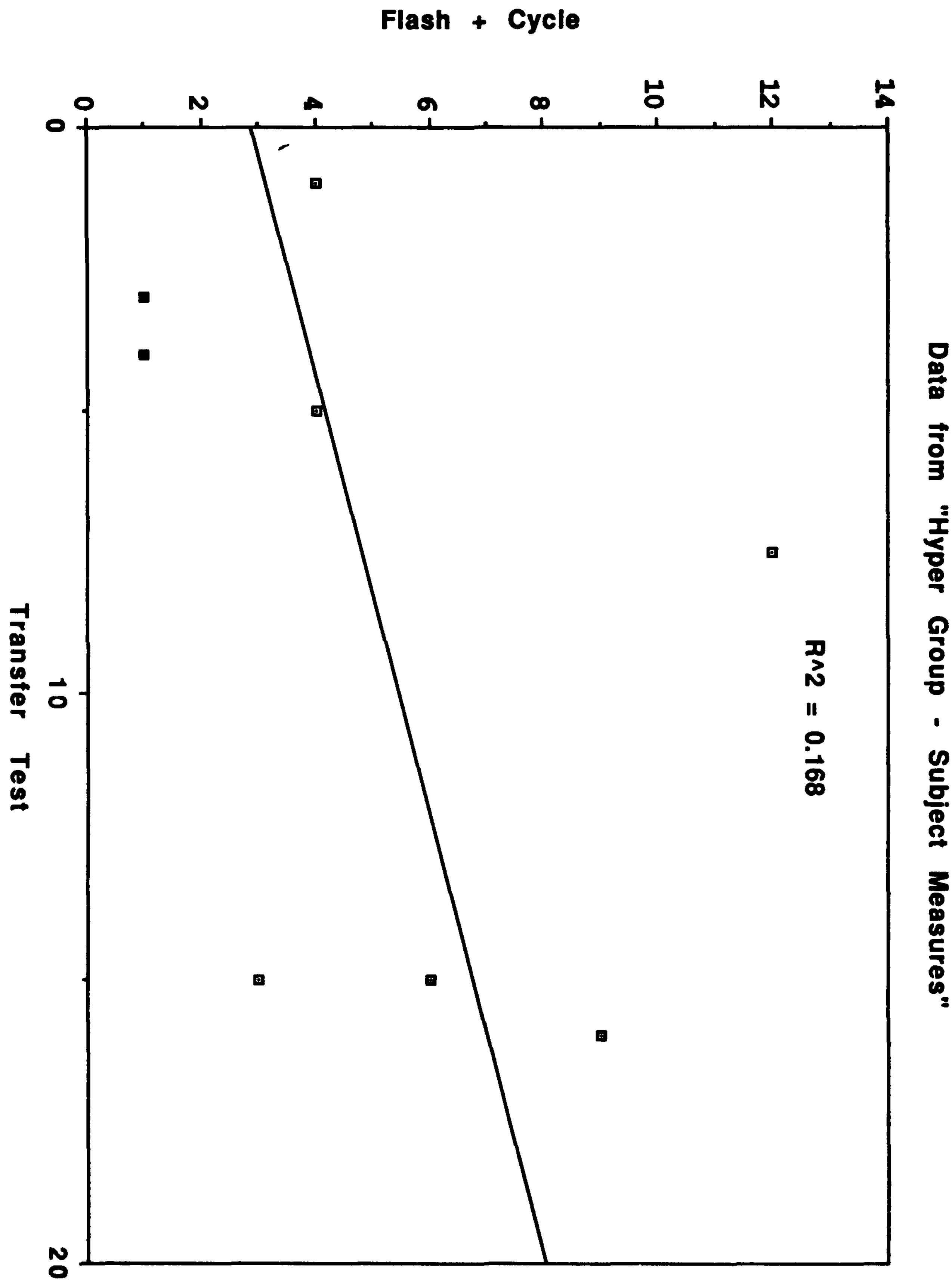

Number of Similar Planes viewed by Both Groups
sim-views -H
sim-views-B
Number of Views
30
20
10
0
A An An:AVb1c14cdrak f15F H:HuJagLKf KiMIMir:Tu2LYak 36
Plane


Number of Looks at Each Plane
Number of Views
Airplanes
0
2
4
6
8
0
10
20
Hyper
Book

Transfer Test

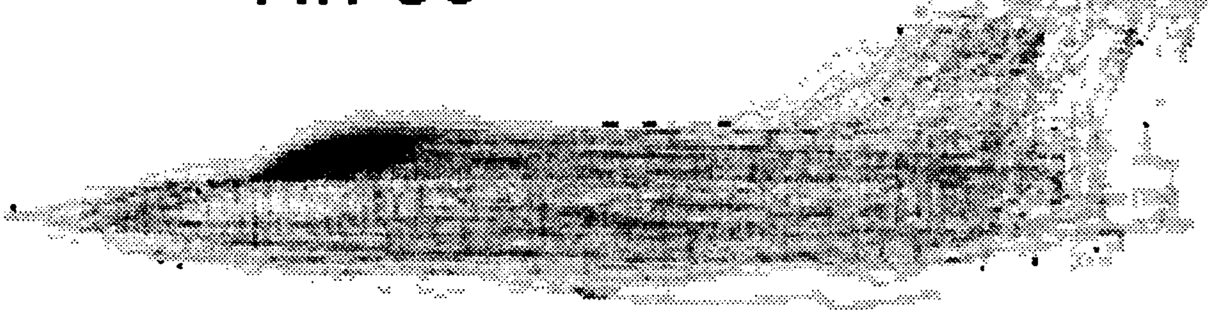



Data from "Hyper Group - Subject Measures"
Colored Contrasts
Flash + Cycle
Number of Contrasts Viewed
0
10
20
2
7
6
4
5
1
8
3
Hyper Group Subjects

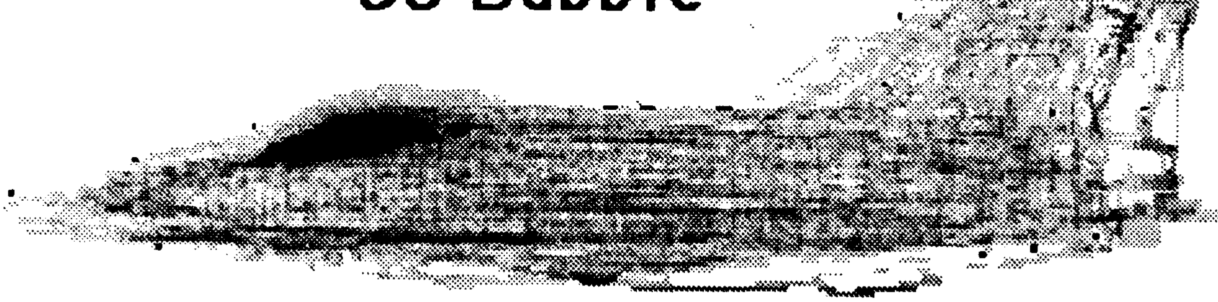

Data from "Hyper Group - Subject Measures"
R^2 = 0.168
Flash + Cycle
Transfer Test
0
2
4
6
8
10
12
14
0
10
20

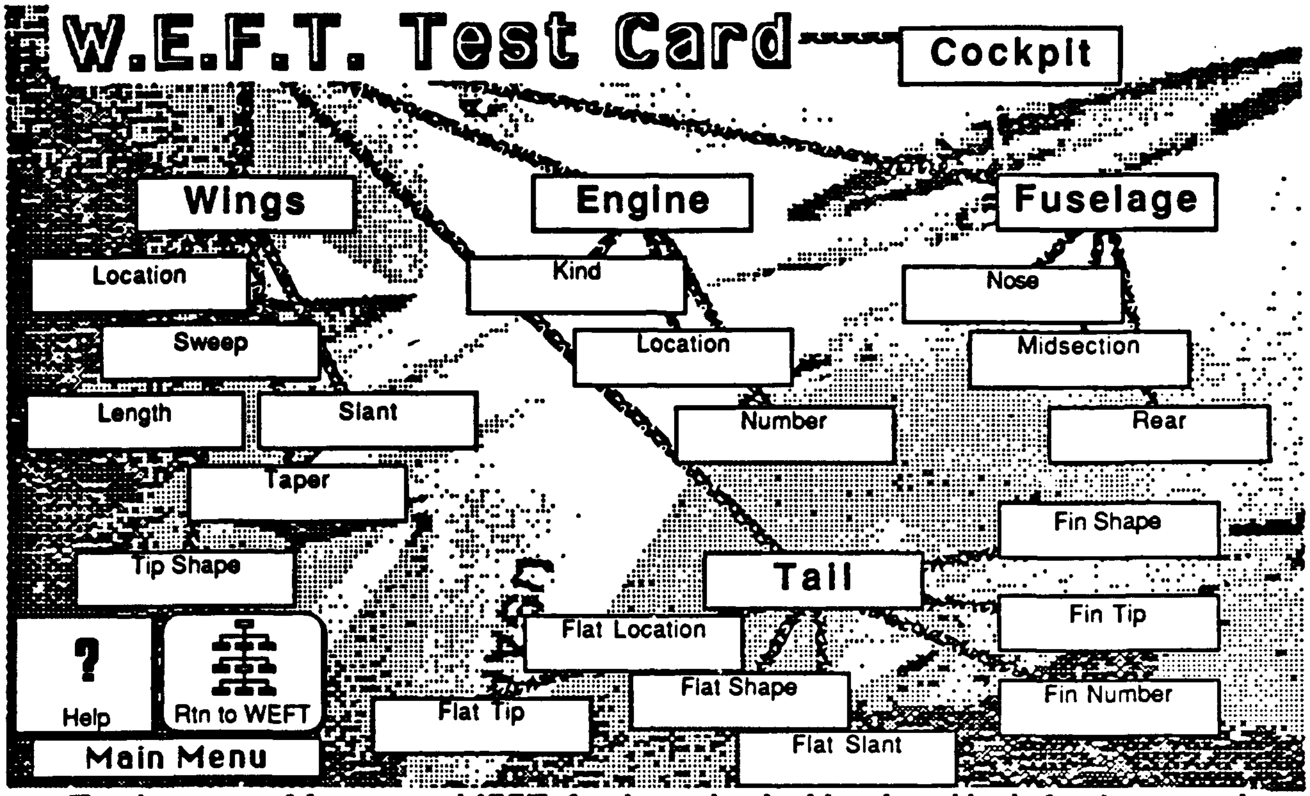
15 Stepped

All 50



35 Bubble





Test yourself on any WEFT feature by buttoning that feature and then answering all the questions that come up ...

Aircraft Role

Attack

Ground Attack

Interceptor

Fighter

Strike

Fighter-bomber

Bomber

Cargo | Transport

Reconnaissance | Surveillance | Observation

Trainer

Main Menu

Click on any button to see all the aircraft that have the selected Role.

Armament

Cannon

Gun

Gun pods

Gun packs

Machine gun

Mini gun

Bombs

Missiles

ALCM

SRAM

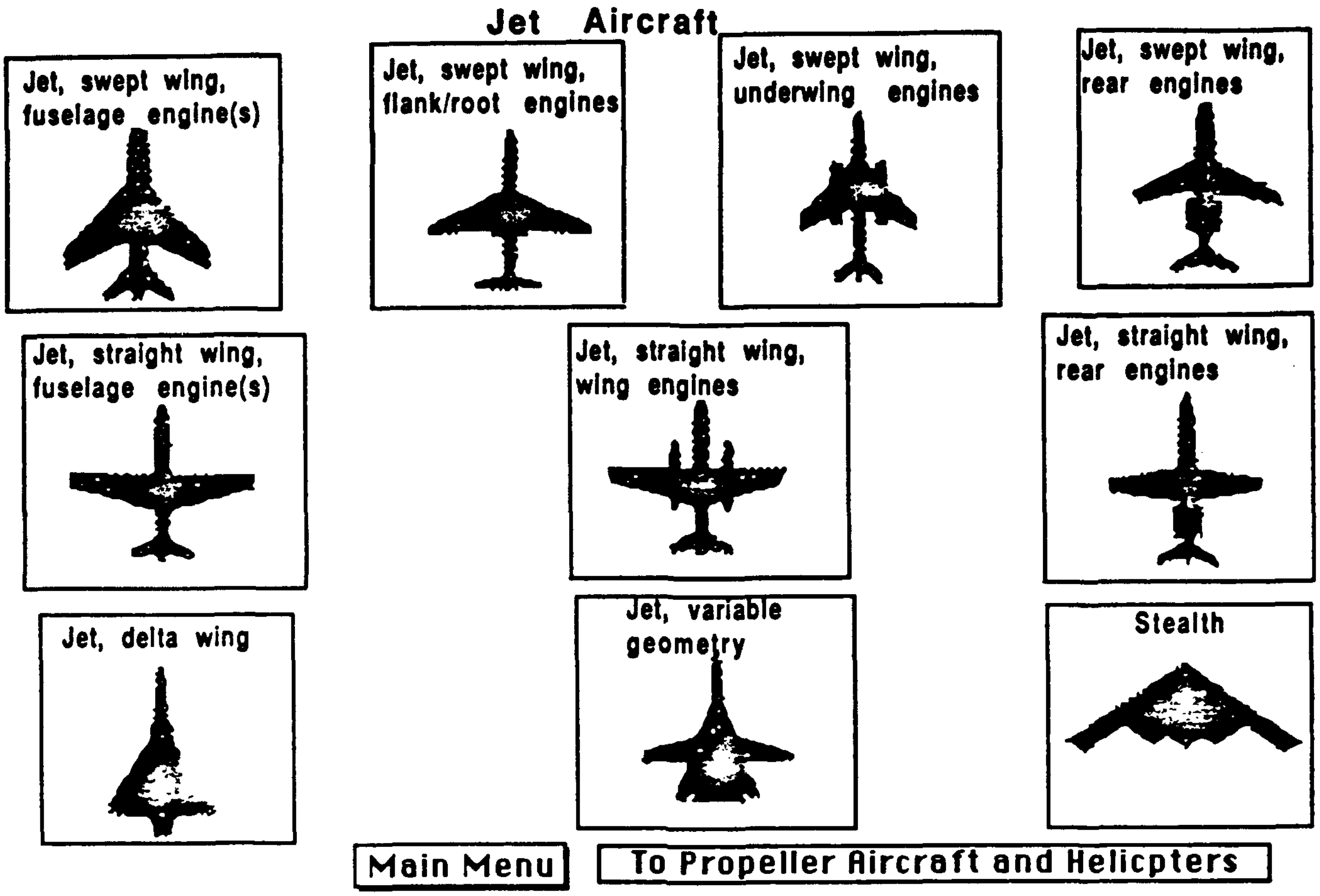
ASM

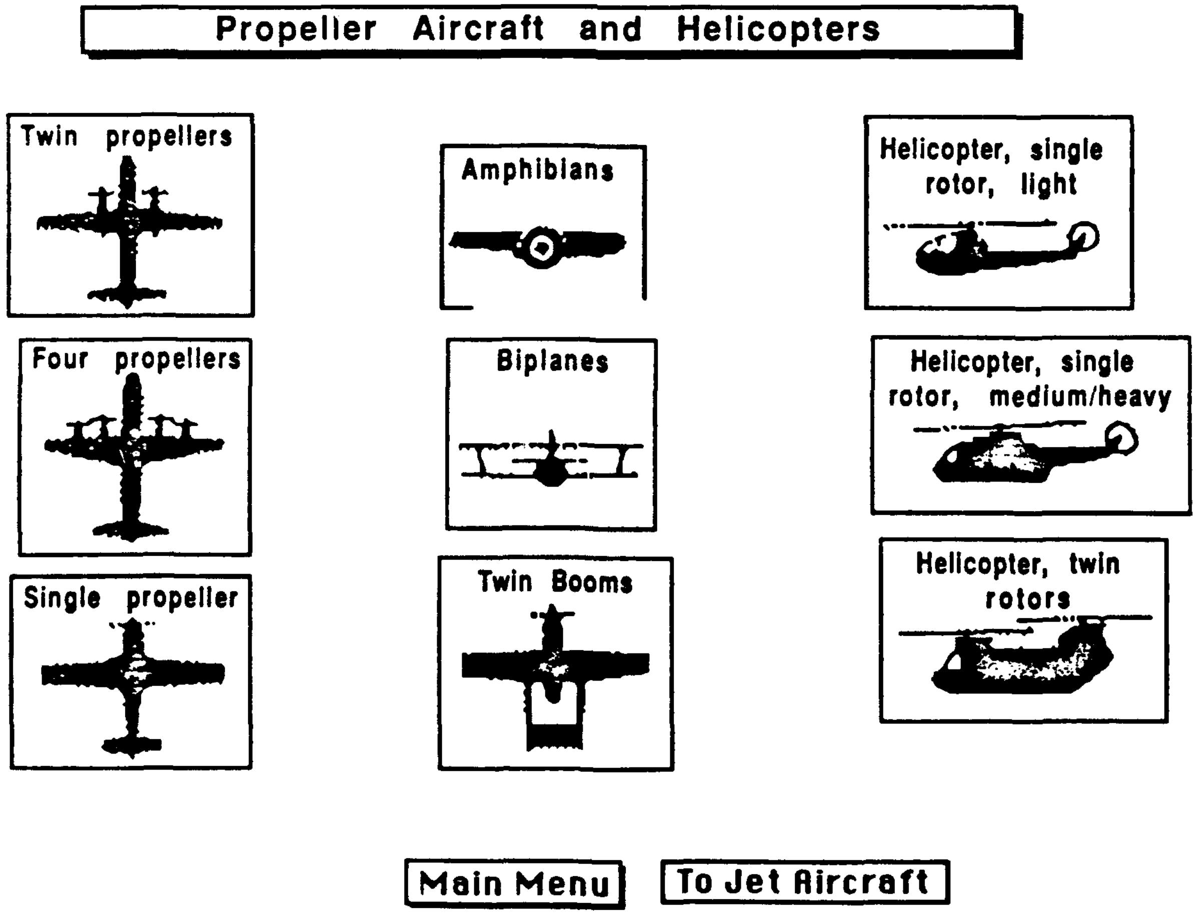
AAM

SAM

Rockets

Main Menu


Jet Aircraft
Jet, swept wing, fuselage engine(s)
Jet, swept wing, flank/root engines
Jet, swept wing, underwing engines
Jet, swept wing, rear engines
Jet, straight wing, fuselage engine(s)
Jet, straight wing, wing engines
Jet, straight wing, rear engines
Jet, delta wing
Jet, variable geometry
Stealth
Main Menu
To Propeller Aircraft and Helicpters


Propeller Aircraft and Helicopters
Twin propellers
Amphibians
Helicopter, single rotor, light
Four propellers
Biplanes
Helicopter, single rotor, medium/heavy
Single propeller
Twin Booms
Helicopter, twin rotors
Main Menu
To Jet Aircraft

Guided Tour

To get an overview of the different aircraft listed below, click the "Take Tour" button. On the tour, click anywhere to go to the next plane.

USA

- AWACS
- A-6 INTRUDER
- A-10 Thunderbolt II
- B-52
- AH-64 APACHE
- F-4 PHANTOM
- F-15 Eagle
- F-16 FIGHTING FALCON
- F-111
- F-117A

Take Tour

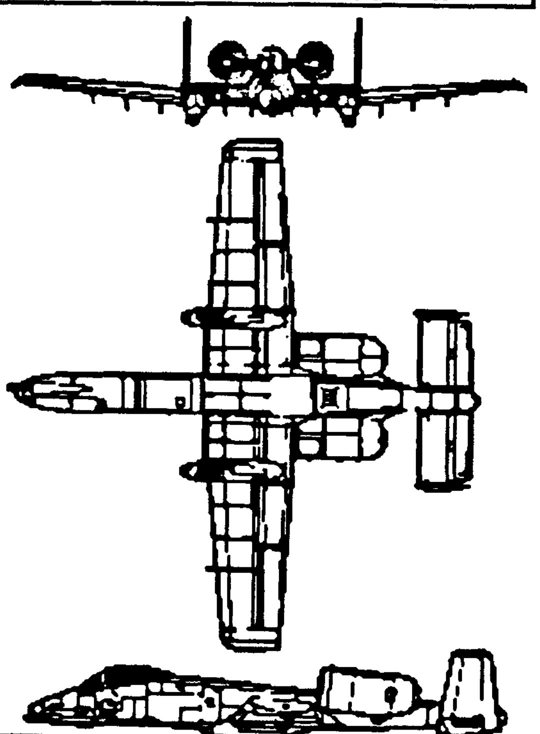
IRAQ

- MIRAGE-F1
- Mi-24 HIND
- MiG-23 Flogger B
- MIG-29 Fulcrum
- Su-24 FENCER

Take Tour

Main Menu

A-10 THUNDERBOLT II



Country of Origin. USA.
Similar Aircraft. None.

Users

Crew. One.
Role. Close air support, ground attack.

Armament. 30-mm cannon, bombs, rockets, HELLFIRE missiles, gun pods.
Dimensions. Length 53 feet, span 58 feet.
Wings. Wings are low mounted on the fuselage, unequally tapered, with blunt curled-under tips. Landing gear pods extend forward of the wings' leading edges.

Sound

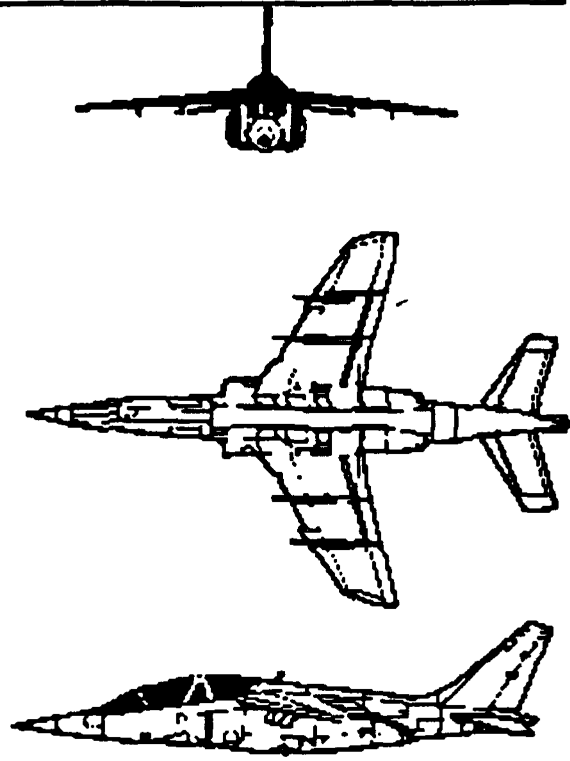
Engine(s). Two turbofan engines in pods, high on the rear of the body between the wings and the tail section.

Fuselage. Rounded nose, tapered rear, bubble canopy. Protrusion in nose is the 30-mm GAU-8 cannon.

Tail. Two tail fins on tips of flat. Unequally tapered fins extend above and below the tail flat. Rectangular tail flat is low-mounted on fuselage.

Picture | Type | Menu | index | Shape | User

ALPHA JET



Country of Origin. **France, West Germany.** Users

Similar Aircraft. **Hawk.**

Crew. **Two**

Role. **Light attack, advanced trainer.**

Armament. **Gun pods, bombs, rockets, missiles.**

Dimensions. **Length 40 feet, span 30 feet.**

Wings. **High-mounted, swept-back, and tapered with curved tips, slight negative slant.**

Sound

Engine(s). **Two alongside body under the wings, oval shaped air intakes forward of the wings' leading edges. Exhausts at the rear of wings' trailing edges.**

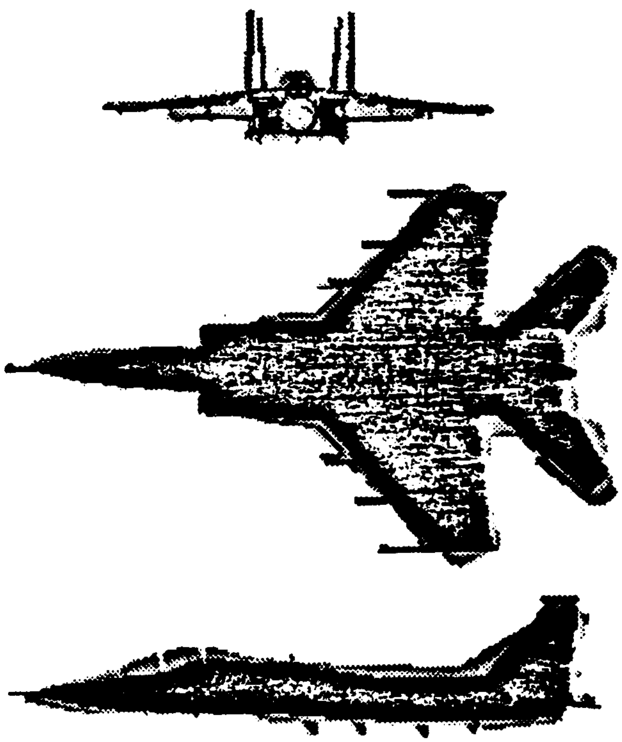
Fuselage. **Slender, pointed nose and tail. Two-seat bubble cockpit.**

Tail. **One Swept-back and tapered tail fin with squared tip.**
Swept-back and tapered tail flats mid-mounted on body with negative slant and square tips.

Flash it | Contrast it | Type | Menu | index | Shape | User

FLASHES "HAWK"

SUPERIMPOSES "HAWK"



CREW, GROUP AND UNIT TRAINING

Opening Remarks

Aircrew Coordination Training R&D:

Dr. David Baker, NTSC
Mr. Randall Oser, NTSC
Major Wes Woodruff, USAF, NTSC

ORGANIZATIONAL VARIABLES AND AIRCREW COORDINATION: IMPLICATIONS FOR TEAM TRAINING

MARY D ZALESNY
KENT STATE UNIVERSITY

DAVID P. BAKER
CAROLYN PRINCE
EDUARDO SALAS
NAVAL TRAINING SYSTEMS CENTER

BACKGROUND

- HUMAN ERROR IS A LEADING CAUSE OF AVIATION MISHAPS.
- AIRCREW COORINATION TRAINING (ACT) HAS BEEN IDENTIFIED AS AN APPROACH FOR OFFSETTING AIR MISHAPS.
- ORGANIZATIONAL VARIABLES ARE LIKELY TO IMPACT ACT AND CAN NOT BE IGNORED.

RESEARCH OBJECTIVES

- GATHER INFORMATION FROM RESERVE AVIATION SQUADRONS RELATED TO:
  - AIRCREW COORDINATION
  - TEAM PERFORMANCE
  - RESOURCE MANAGEMENT
- IDENTIFY CRITICAL ORGANIZATIONAL VARIABLES
- IDENTIFY FUTURE RESEARCH NEEDS

MILITARY RESERVES

- UNIQUE ORGANIZATION TO STUDY FOR SEVERAL REASONS:
  - ORGANIZATIONAL MEMBERS HAVE DUAL ALLIANCES.
  - POSITIONS ARE SHARED BETWEEN RESERVES AND ACTIVES.
  - ACTUAL JOB PERFORMANCE MAY NEVER OCCUR.

METHOD

- INTERVIEWS WERE CONDUCTED WITH PERSONNEL FROM MARINE RESERVE SQUADRONS.
- 1715 QUESTIONNAIRES WERE ADMINISTERED TO A STRATIFIED RANDOM SAMPLE OF ALL RESERVE SQUADRONS.
- COLLECTED 3 PERFORMANCE MEASURES:
  - MCCRES
  - CRP
  - CGI

RESULTS

- 3 ORGANIZATIONAL VARIABLES WERE IDENTIFIED AS CRITICAL:
  - TRAINING
  - LEADERSHIP
  - COORDINATION

TRAINING

- RESERVES RECEIVED SIGNIFICANTLY LESS MOS TRAINING AND OJT PRIOR TO JOINING A SQUADRON.
- THE DEGREE OF TRAINING RECEIVED WAS AFFECTED BY THE MAG/SITE/SQUADRON COMMANDERS.

LEADERSHIP

- LEADERSHIP WAS STRONGLY RELATED TO PERCEPTIONS OF SQUADRON FUNCTIONING.
- COMMANDERS AND THEIR SQUADRONS VIEW THE SQUADRON DIFFERENTLY.
- COMMANDERS DID NOT FEEL PREPARED FOR THE LEADERSHIP RESPONSIBILITIES OF A RESERVE SQUADRON.

COORDINATION

- COORDINATION WAS VIEWED AS CRITICAL - ESPECIALLY FOR OFFICERS.
- COORDINATION MUST OCCUR BETWEEN:
  - TEAM MEMBERS.
  - ACTIVES AND RESERVES IN SIMILAR POSITIONS.
  - VARIOUS SQUADRON FUNCTIONS (e.g., OPERATIONS, MAINTENANCE, ETC.).

PERFORMANCE

- % OF RESERVISTS IN THE SQUADRON WAS RELATED TO:
  - CRP
  - CGI
- VARIABLES NOT RELATED INCLUDED:
  - DRILL TIME SPENT ON INSPECTIONS
  - PREPARATION FOR RESERVE SQUADRON
  - DEGREE OF COORDINATION REQUIRED

SUMMARY

- THE RESULTS SHOWED THREE ORGANIZATIONAL VARIABLES TO BE CRITICAL:
  - TRAINING
  - LEADERSHIP
  - COORDINATION
- THESE VARIABLES ARE LIKELY TO HAVE AN IMPACT ON AIRCREW COORDINATION AND TEAM PERFORMANCE IN GENERAL.

FUTURE RESEARCH

- IDENTIFY OTHER IMPORTANT ORGANZATIONAL VARIABLES THAT CAN IMPACT TEAM PERFORMANCE.
- DETERMINE SPECIFIC RELATIONSHIPS BETWEEN ORGANIZATIONAL VARIABLES AND AIRCREW COORDINATION.
- DETERMINE NEW METHODS TO OFFSET ORGANIZATIONAL VARIABLES.
    - TEAM TRAINING FOR ACTIVE DUTY AND RESERVES.

AIRCREW COORDINATION TRAINING INTEGRATION

TRAINING TECHNOLOGY TECHNICAL GROUP

MARCH 1992

RANDALL L. OSER

NAVAL TRAINING SYSTEMS CENTER
ORLANDO, FL

AIRCREW COORDINATION TRAINING (ACT) INTEGRATION

- PRESENTATION OVERVIEW
  - ACT AND INTEGRATION
  - INTEGRATION RESEARCH QUESTIONS
  - LEVELS OF INTEGRATION
  - 'SEAMLESS' INTEGRATION OF ACT: V-22
  - RESEARCH REQUIRED
  - CONCLUSIONS

AIRCREW COORDINATION TRAINING INTEGRATION

- RESEARCH QUESTIONS
  - WHAT IS THE MOST EFFECTIVE METHOD FOR INTEGRATING SKILL-BASED AIRCREW COORDINATION TRAINING INTO 'STICK AND RUDDER' AIRCREW TRAINING?
  - CAN AIRCREW COORDINATION SKILLS BE TRAINED IN PARALLEL WITH 'STICK AND RUDDER' AIRCREW TRAINING?
  - WHEN SHOULD AN INTEGRATED APPROACH BE USED OR NOT USED?

AIRCREW COORDINATION TRAINING INTEGRATION

- RESEARCH QUESTIONS (Cont.)
  - HOW SHOULD AN INTEGRATED APPROACH BE EVALUATED?
  - WHEN IS THE MOST APPROPRIATE TIME TO INTRODUCE AND TRAIN AIRCREW COORDINATION SKILLS?

'STAND-ALONE' INTEGRATION

KNOWLEDGE

- Provide Platform Specific Information (i.e., Modules)

DEMONSTRATION

- Demonstrate Effective/Ineffective Behaviors

PRACTICE/ FEEDBACK

- Develop Skills
- Reinforce Skills

GROUND SCHOOL	AIRCREW COORDINATION TRAINING	SIM/FLT TRAINING

'EMBEDDED' INTEGRATION

KNOWLEDGE	DEMONSTRATION	PRACTICE/ FEEDBACK
• Aircrew Coordination Information (i.e., Modules) • Mission Specific	• Demonstrate Effective/Ineffective Behaviors • Synthesize Information to Specific Operational Situations	• Develop Skills • Reinforce Skills

ACT ACT ACT ACT

GROUND SCHOOL | SIM/FLT TRAINING

'SEAMLESS' INTEGRATION

KNOWLEDGE	DEMONSTRATION	PRACTICE/ FEEDBACK
• Aircrew Coordination Information • System Specific	• Demonstrate Effective/Ineffective Behaviors • Synthesize Information to Specific Systems and Operational Situations	• Develop Skills • Reinforce Skills
GROUND SCHOOL	PRE-SIM/FLT TRAINING LAB	SIM/FLT TRAINING

AIRCREW COORDINATION TRAINING
V-22 ACT INTEGRATION

- IMPLICATIONS FOR 'SEAMLESS' INTEGRATION
  - GLASS COCKPIT
  - AUTOMATED SYSTEMS
  - TILT-ROTOR FLIGHT PROFILE
  - DEVELOPMENTAL PROGRAM
  - OPERATIONAL TRAINING ENVIRONMENT

AIRCREW COORDINATION TRAINING
V-22 ACT INTEGRATION

- APPLICATION OF 'SEAMLESS' INTEGRATION
  - REVIEW OF RELEVANT LITERATURE
  - CONDUCT NEEDS ANALYSIS
  - IDENTIFICATION OF CRITICAL TASKS REQUIRING COORDINATION
  - DEVELOPMENT OF PROTOTYPE MATERIALS (i.e., INTEGRATED GROUND SCHOOL TRAINING MATERIALS, SIMULATOR EXERCISES)
  - UTILIZATION AND EVALUATION OF TRAINING MATERIALS

Outline of Instruction		Instructor Activity
After selecting the ILS key, the pilot will be prompted to tune the desired ILS frequency and select the desired ILS front course bearing, final decision height, final approach speed and the intercept track (heading) under the VOR/ILS COURSE, ILS FS/DH and TRACK CDU legend/keys. **Pilots should decide on all parameters to be entered prior to selecting the ILS key.** When the <u>front course</u> bearing is entered, the heading for a <u>30°</u> intercept will appear under the REF HEADING legend. The reference heading can be changed by the pilot provided the intercept angle is <u>less than 90°</u>.	_.	**State that it is important to ensure that the entire crew is aware that an ILS approach will be performed.**
When data entry is complete, the TRK mode will be activated and the is ILS armed, causing the TRK legend to update to TRK* and the ILS legend to ILS ARM. The system heading reference will be <u>automatically</u> set to <u>magnetic</u>.	_.	**Stress the importance of pilots anticipating and communicating all legend updates during ILS approaches fo ensure the system is functioning properly and to maintain situational awareness.**
NOTE: Arming the ILS mode will also cause the filters for the localizer and glideslope signals to be initialized. These filters provide smoothed estimates of the variables required for the ILS guidance processing.		
a) <u>Localizer Geometry</u>	28.	Show transparency V-22-PLTFDS-0020 and direct students to the Student Workbook, 2.11.3.
Once the ILS mode is armed, the aircraft will turn to the entered ground track angle to intercept the ILS localizer angle. **Pilots should monitor aircraft performance against expected aircraft performance.**		

GROUND OPERATIONS

NOTE: IC at TAKEOFF POSITION

ILS Exercise:

Call waveoff prior to DECISION HEIGHT alert, requiring pilot to quickly assume manual control of the aircraft.

[ ] Perform - Normal Instrument Pretakeoff Checks

FLIGHT OPERATIONS

[ ] Perform - Short Instrument Takeoff

[ ] Perform - Instrument Conversion and Climbout, Flight Director

[ ] Perform - Flight using VOR, TACAN - Airplane Mode/Conversion Mode, Flight Director - Commanded

[ ] Perform - Missed Approach/Wave Off - Flight Director - Commanded

NOTE: IC at TAKEOFF POSITION

[ ] Perform - Normal Instrument Takeoff

[ ] Perform - Instrument Conversion and Climbout

[ ] Perform - Instrument Approach: VOR, Flight Director - Commanded

[ ] Perform - Landings from Instrument Approach - Short Landing

NOTE: IC at Final Instrument Approach Position

[ ] Perform - Instrument Approach: ILS, Flight Director

ILS Approach:

[ ] Pilots announce to crew/ensure crew aware that ILS approach will be conducted

[ ] Prior to selecting ILS key, pilots have decided on all parameters to be entered (i.e., ILS front course bearing, final decision height, final approach speed, and intercept track (heading)).

Pilot not flying:

- [ ] Enters and checks data
- [ ] Communicates TRK legend update to TRK* and ILS legend update to ILS ARM

[ ] Pilots monitor aircraft turn to ground track angle

[ ] Pilots note LOC CAPTURE annunciator, TRK* mode update to TRK, and ILS ARM update to ILS*

[ ] Pilots monitor aircraft pitchover/descent to glideslope

[ ] Pilot flying communicates readiness to assume aircraft control

[ ] Pilots note DECISION HEIGHT alert

[ ] Pilot flying announces he is assuming control of the aircraft

[ ] Pilot flying assumes control of the aircraft and announces when he has control of the aircraft

[ ] Perform - Landings from Instrument Approach - Hover Vertical Landing

[ ] Perform - Normal Shutdown

POST FLIGHT OPERATIONS

[ ] Review - Problem areas

[ ] Preview next flight

AIRCREW COORDINATION TRAINING INTEGRATION

- RESEARCH REQUIRED
  - LABORATORY STUDIES
  - OPERATIONAL/FIELD STUDIES
  - SKILL RETENTION
  - TRAINING OPTIMIZATION
  - PERFORMANCE MEASUREMENT

AIRCREW COORDINATION TRAINING INTEGRATION

- CONCLUSIONS
  - IMPLICATIONS OF RESEARCH
  - CONSTRAINTS OF THE OPERATIONAL ENVIRONMENT
  - INTRODUCTION OF NEW TECHNOLOGIES
  - APPLICATION OF INTEGRATED ACT IN MILITARY AND CIVILIAN AVIATION ENVIRONMENTS

TABLE TOP AIRCREW COORDINATION TRAINING SYSTEM

(T-TACTS)

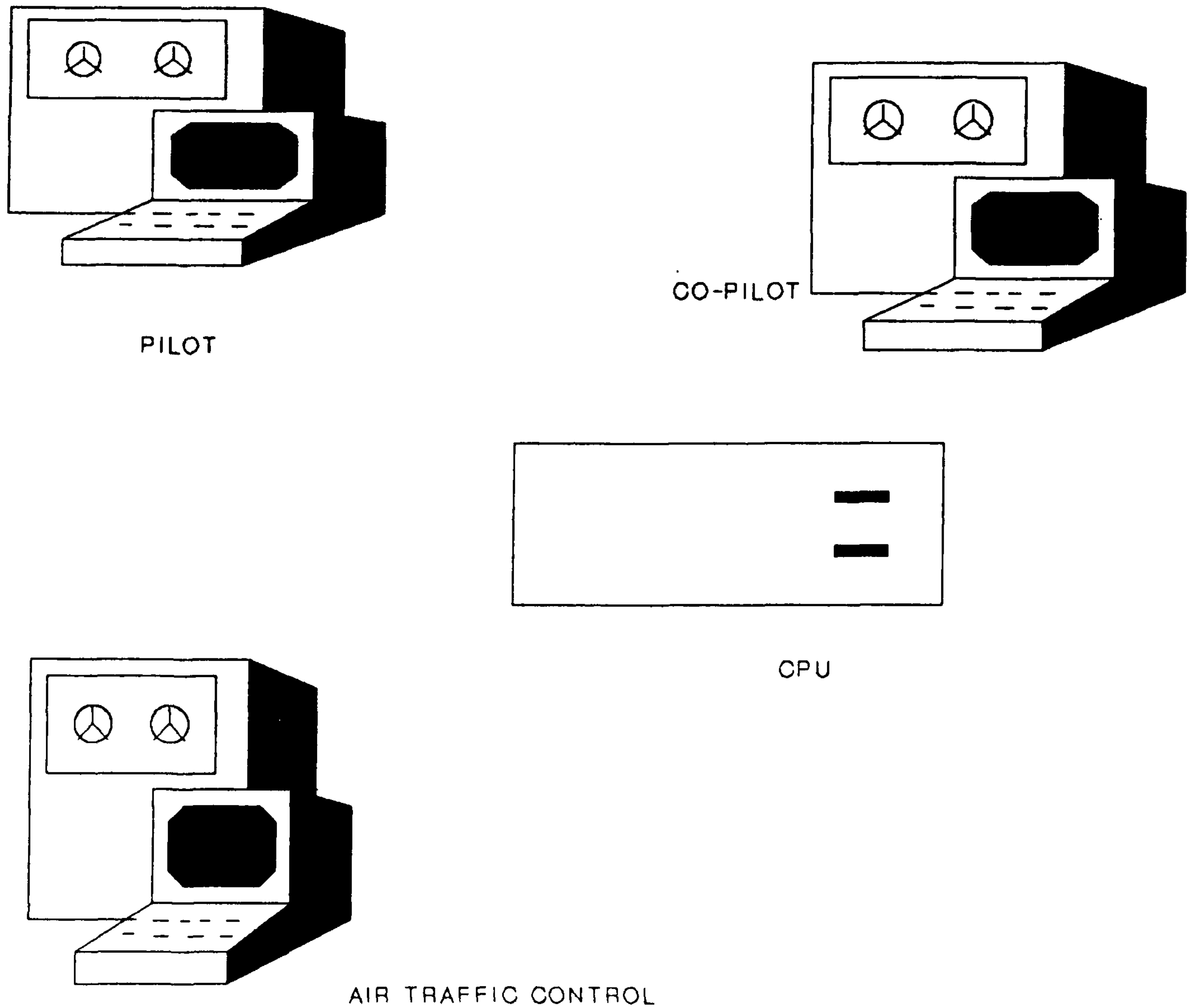
MAJ WES WOODRUFF
NTSC AIR FORCE LIAISON OFFICER

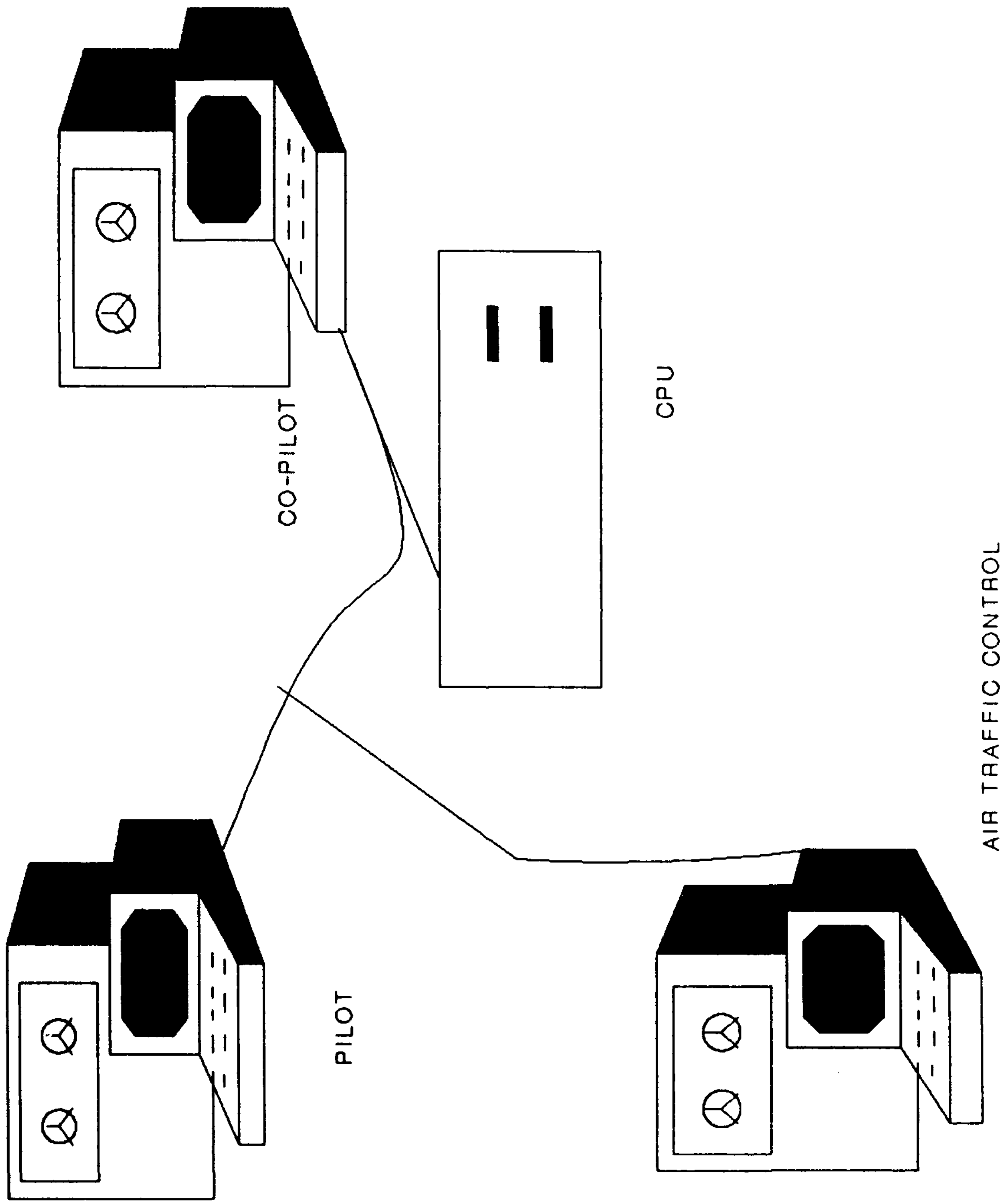
OVERVIEW

- EQUIPMENT
- SOFTWARE
- SCENARIO DEVELOPMENT
- FUTURE ENHANCEMENTS/PROGRAMS

EQUIPMENT

- IBM 286 OR 386 PC
- MICROSOFT FLIGHT SIMULATOR
  - AIRCRAFT AND SCENERY DESIGN
  - SCENERY DISKS
  - VGA UPGRADE
- FLIGHT CONTROLS
- HEADSETS AND SPLITTER BOXES


PILOT
CO-PILOT
CPU
AIR TRAFFIC CONTROL


CO-PILOT
CPU
PILOT
AIR TRAFFIC CONTROL

SOFTWARE

- INEXPENSIVE

  TOTAL COST $ 130.00

- REAL WORLD

- EASY TO LEARN

  15 MINUTE ORIENTATION

- <u>NOT</u> A FLIGHT TRAINER

SCENARIO DEVELOPMENT

- LOCATIONS IN FS DATA BASE
  - USE FLIGHT PUBLICATIONS
  - UNFAMILIAR AREA TO SUBJECTS
- 20 MINUTES LONG
- NO EQUIPMENT FAILURES
  - NOT MAKING SUBJECTS EXPERTS ON FS
- HIGH DEGREE OF REALISM
  - ATC COMM
  - AIRCREWMAN, PAX ON BOARD

SCENARIO DEVELOPMENT (cont)

- SCENARIOS
  - C-12 TYPE AIRCRAFT
  - TRANSPORTING AN ADMIRAL FROM A TO B
- CREW PROBLEMS TO SOLVE
  - LOST COMMUNICATION
  - PASSENGER HAS HEART ATTACK

FUTURE ENHANCEMENTS/PROGRAMS

EQUIPMENT

- SOUND BOARD
- MORE AND VARIED ATC COMMUNICATIONS
- LARGER TEAMS
- ELIMINATION OF KEYBOARD
- THROTTLE, GEAR AND FLAP HANDLE

PROGRAMS

- T-34
- F-18
- T-44
- A-6
- USMC RESERVES

TRAINING DESIGN AND EVALUATION

Instructional, Planning and Evaluation Issues

Modeling Skill Acquisition:
Dr. Mark Sabol

Retention of Knowledge Learned in College:
Dr. John Ellis

MODELS OF SKILL ACQUISITION

MARK SABOL
ARMY RESEARCH INSTITUTE
ALEXANDRIA, VIRGINIA

PRESENTATION AT T2TG MEETING
PHOENIX, ARIZONA
MARCH 25, 1992

TOPICS TO BE DISCUSSED:

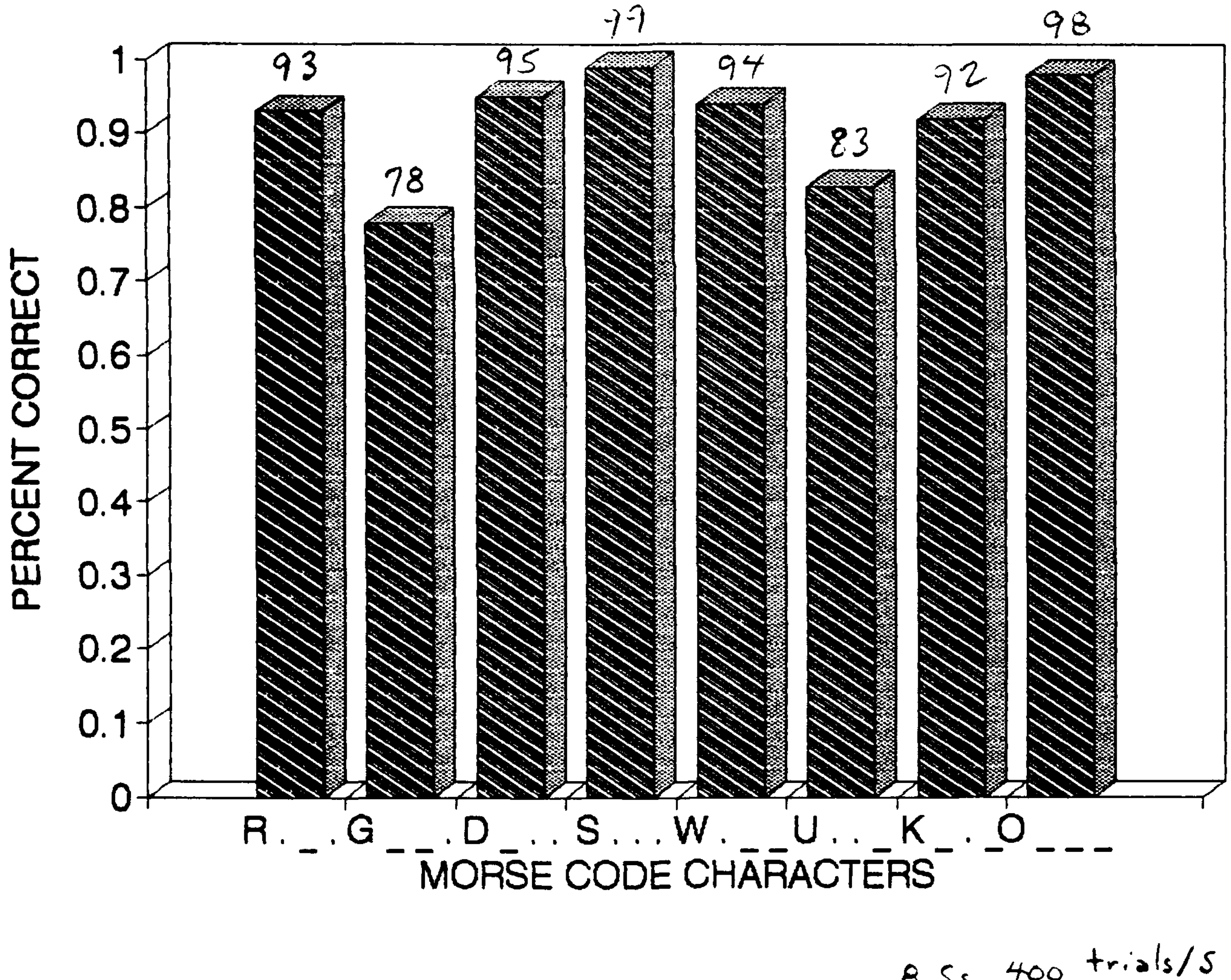
- COMPLETED RESEARCH ON PERCEPTUAL-MOTOR SKILL TRAINING
  - MODELS
  - FINAL ISSUES
- FUTURE RESEARCH
  - COLLECTIVE SKILLS
  - RETRAINING

PRELIMINARY CONFUSION MATRIX RESULTS - SEP 90
(Data from 10 subjects at each speed)

All errors that occurred ≥5% of the time each stimulus was presented (4-element stimuli, only):

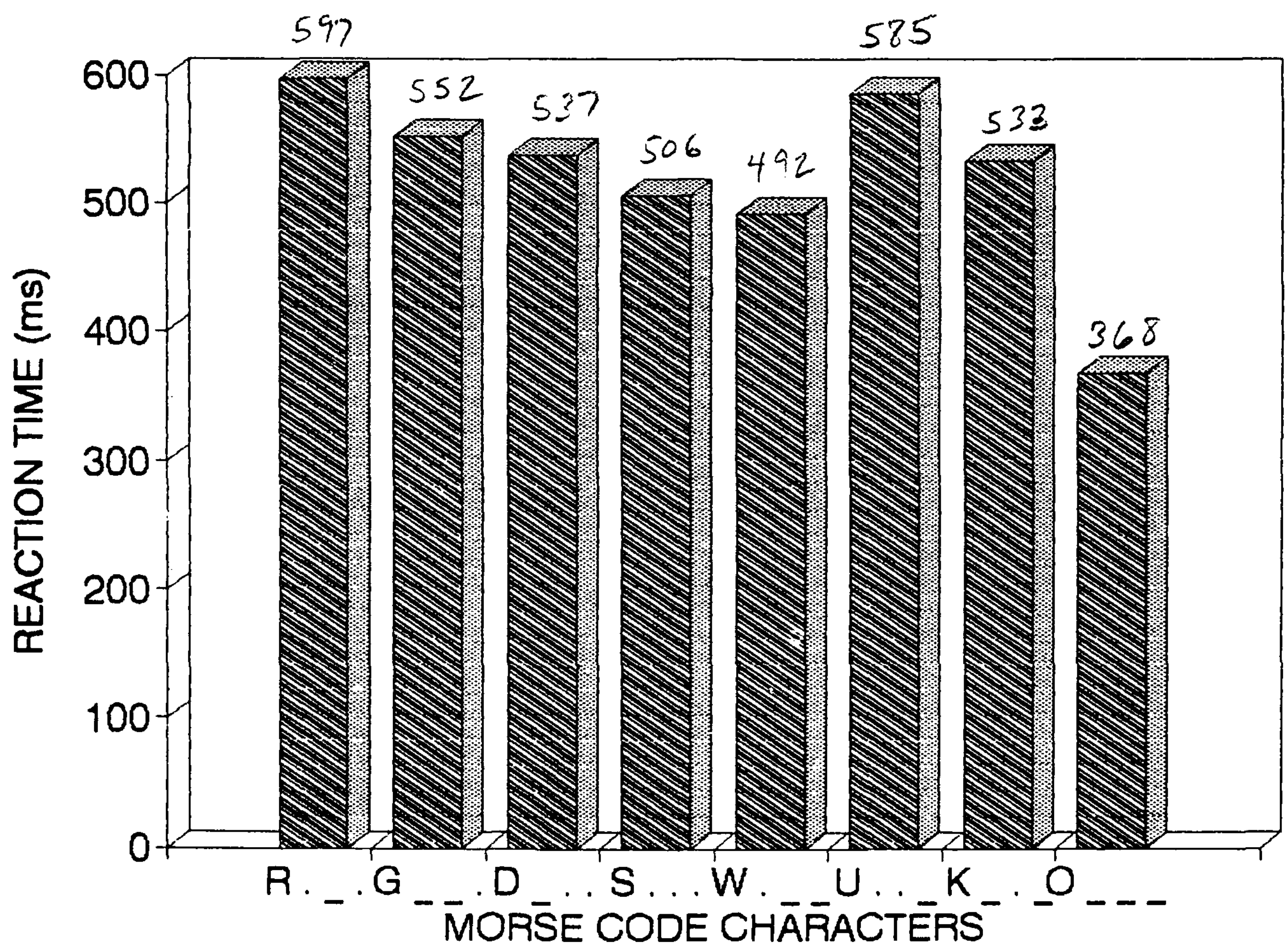
	Speed = 10 Groups per Minute			Speed = 20 Groups per Minute		
Stimulus	H	••••		H	••••	
Response	S	•••	(38%)	S	•••	(21%)
Stimulus	B	-•••				
Response	D	-••	(19%)			
Stimulus				B	-•••	
Response				X	-••-	(6%)
Stimulus	V	•••-		V	•••-	
Response	U	••-	(10%)	U	••-	(7%)
Stimulus	F	••-•				
Response	L	•-••	(8%)			
Stimulus	L	•-••		L	•-••	
Response	R	•-•	(7%)	R	•-•	(16%)
Stimulus	F	••-•		F	••-•	
Response	U	••-	(6%)	U	••-	(15%)
Stimulus	Y	-•--		Y	-•--	
Response	C	-•-•	(6%)	C	-•-•	(5%)
Stimulus				C	-•-•	
Response				Y	-•--	(6%)
Stimulus	Z	--••				
Response	G	--•	(6%)			
Stimulus				Z	--••	
Response				Q	--•-	(6%)
Stimulus				P	•--•	
Response				W	•--	(9%)
Stimulus				J	•---	
Response				W	•--	(8%)
Stimulus				P	•--•	
Response				J	•---	(7%)

THREE-ELEMENT CHARACTERS

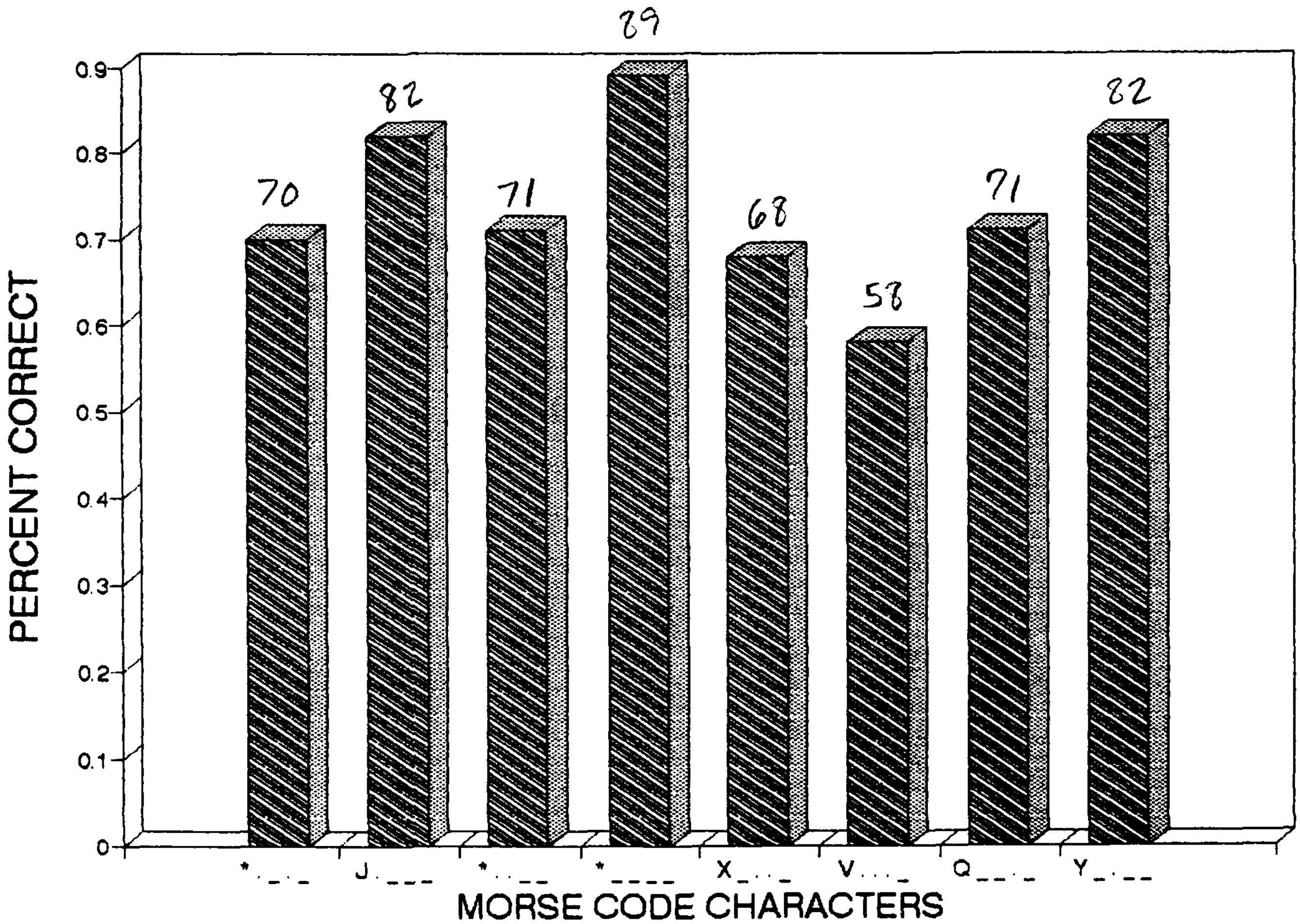


8 Ss, 400 trials/S

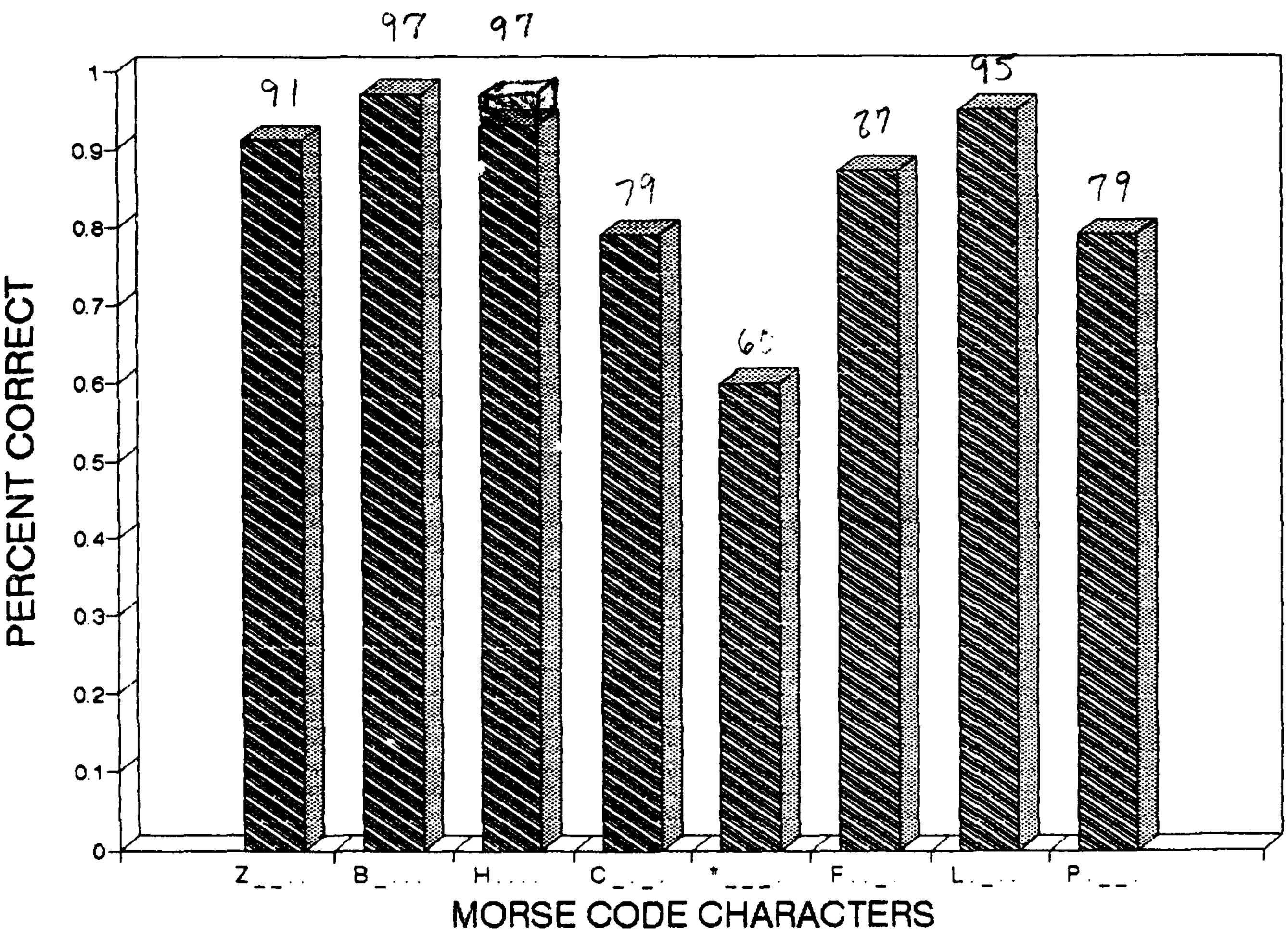
THREE-ELEMENT CHARACTERS



FOUR-ELEMENT CHARACTERS

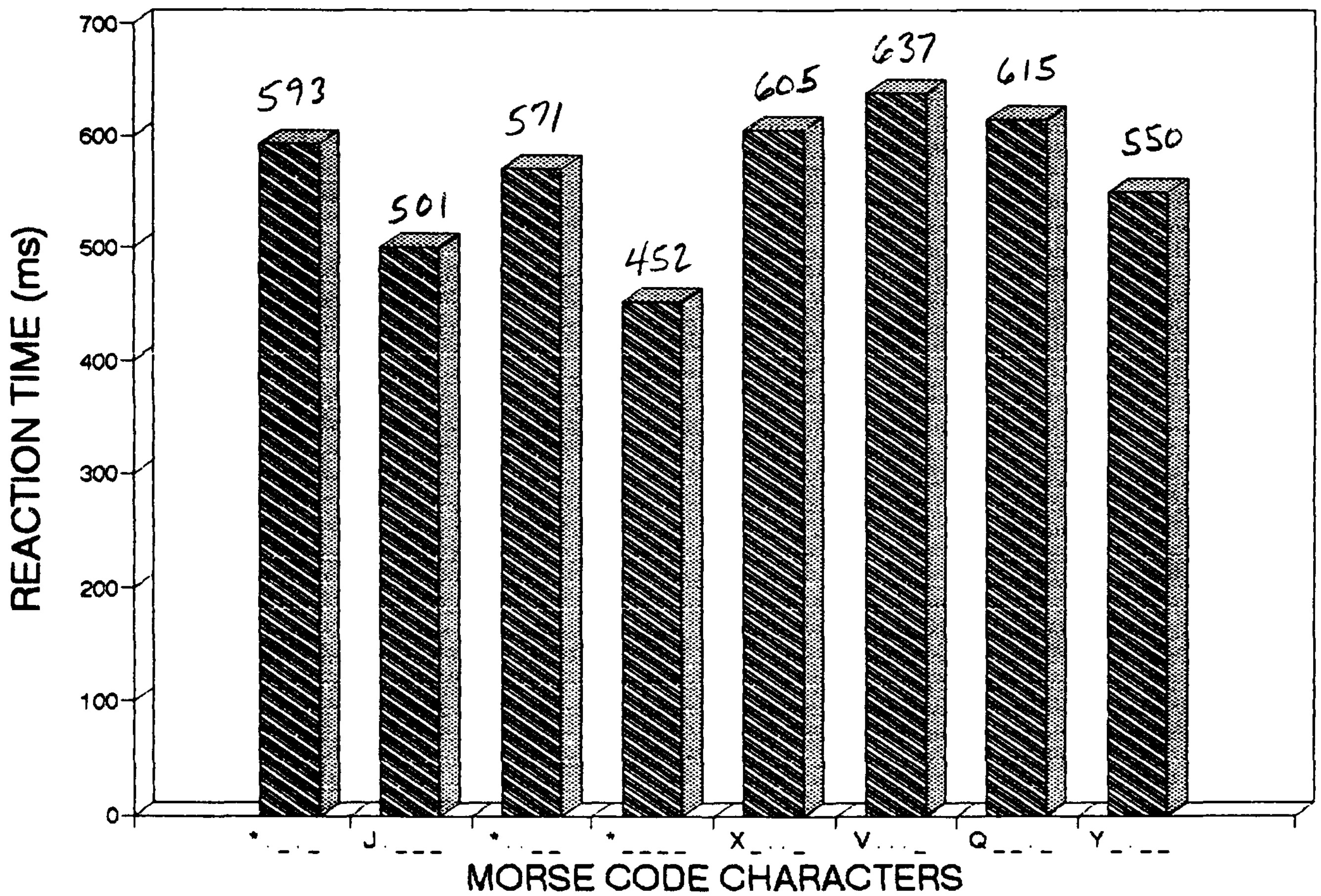


FOUR-ELEMENT CHARACTERS

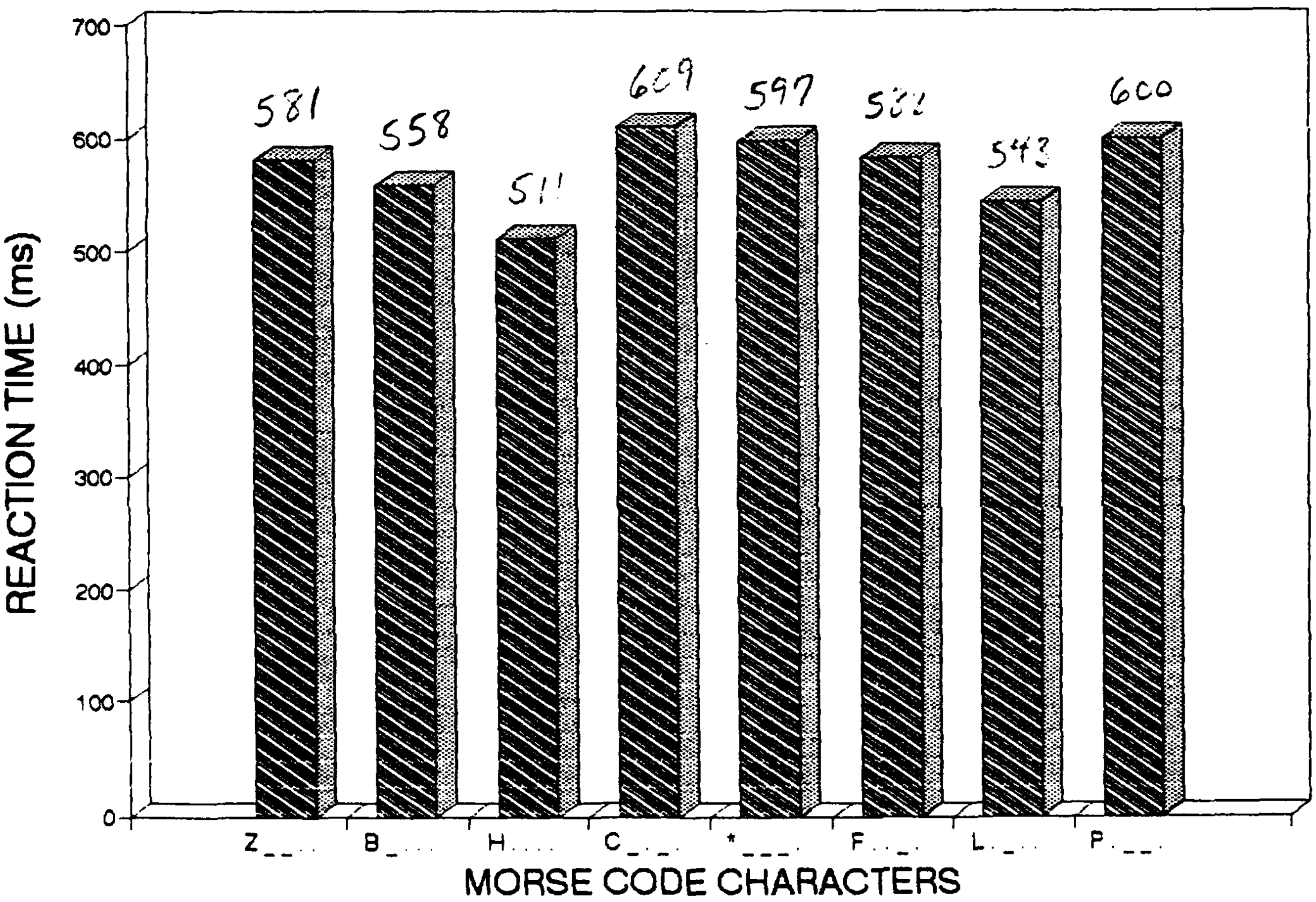


18 Ss, 240 trials/s

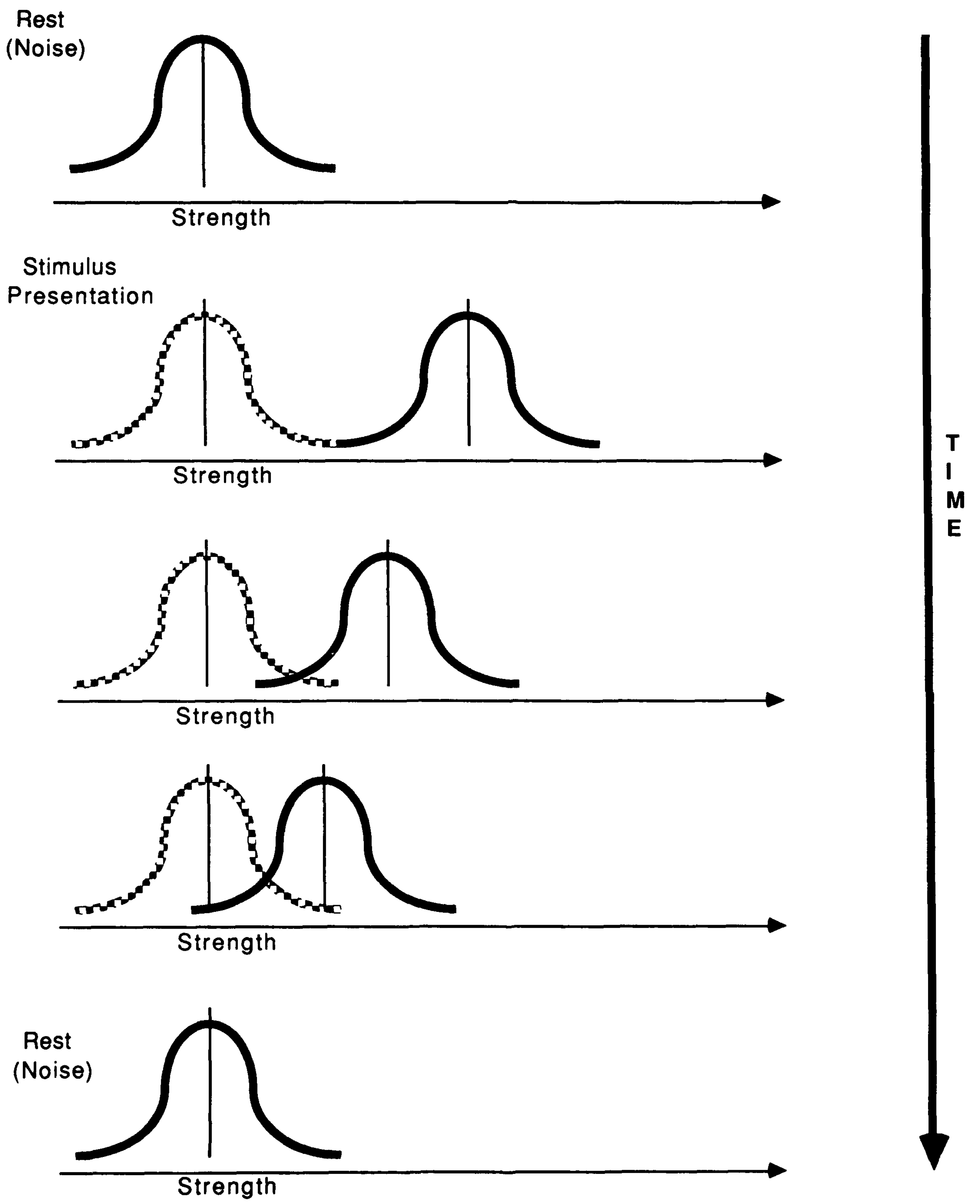
FOUR-ELEMENT CHARACTERS



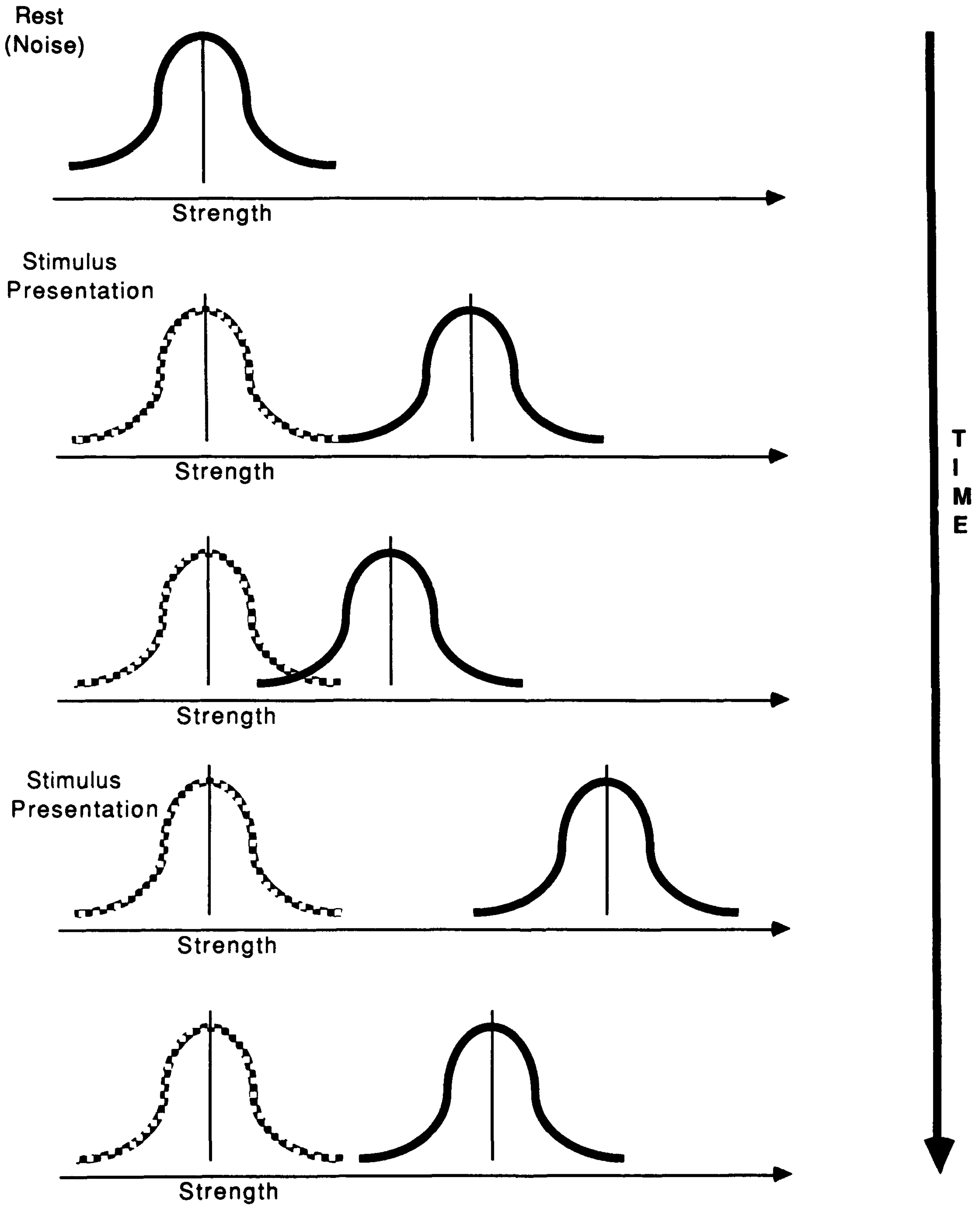
FOUR-ELEMENT CHARACTERS



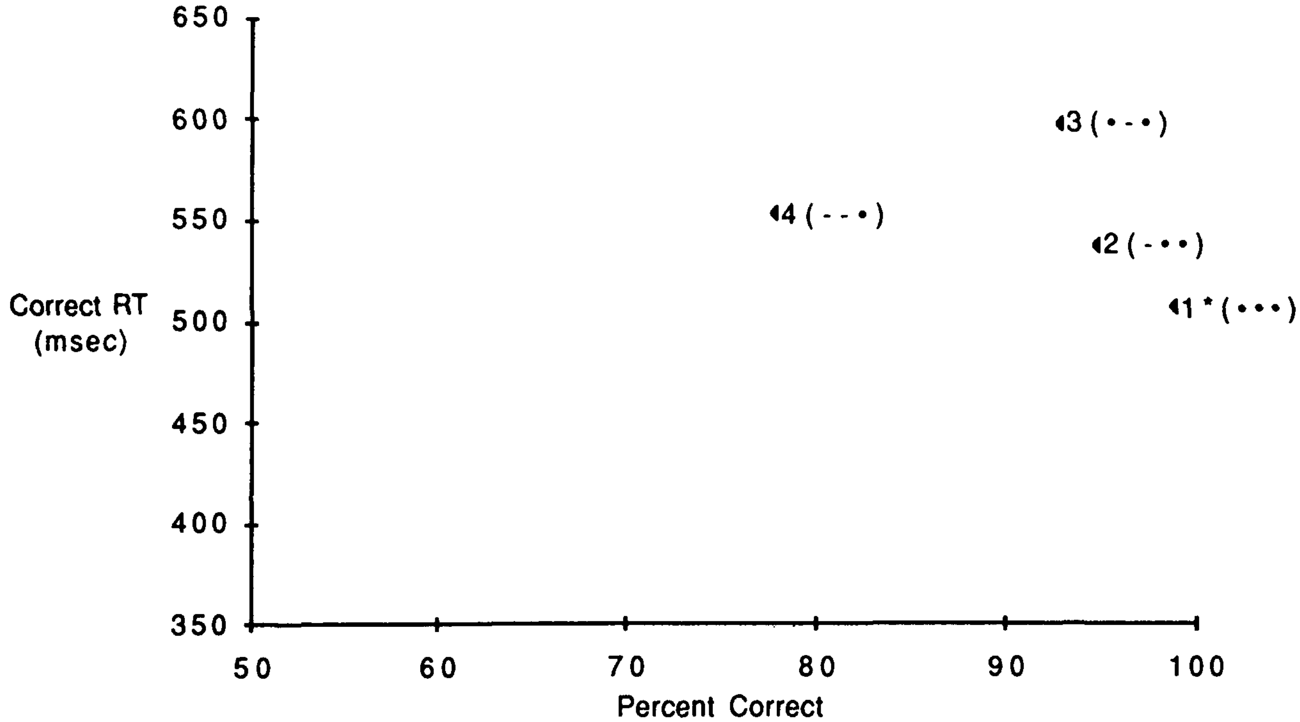
Stimulation and Decay of Trace Strength Register
Single Presentation



Stimulation and Decay of Trace Strength Register
Double Presentation

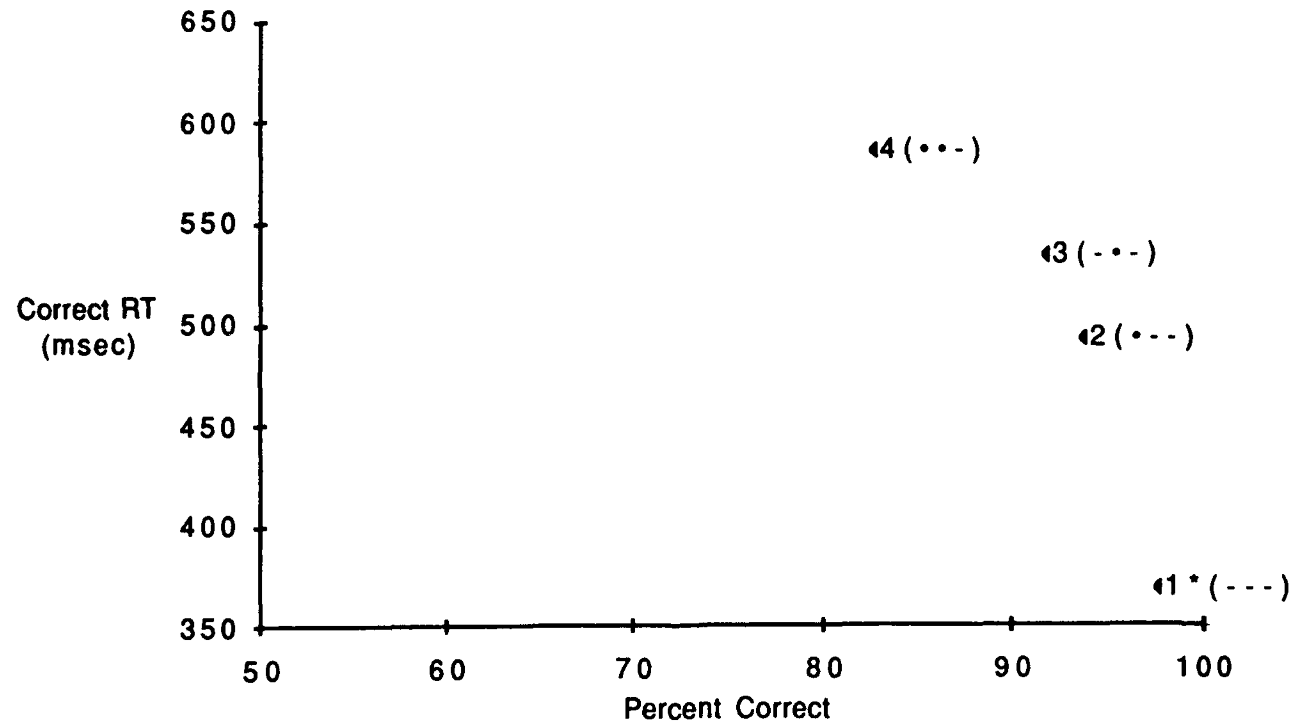


3-Element Characters with a Final "dit"



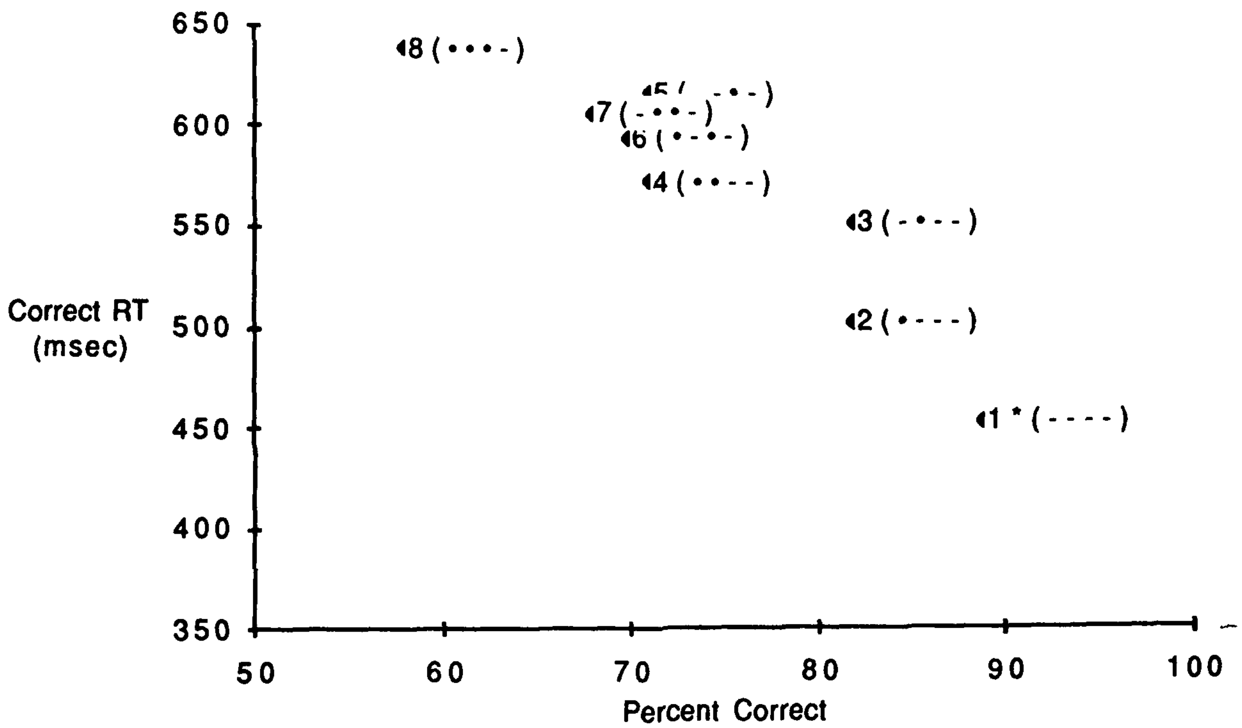
* Character rank predicted
from trace strength model

3-Element Characters with a Final "dah"



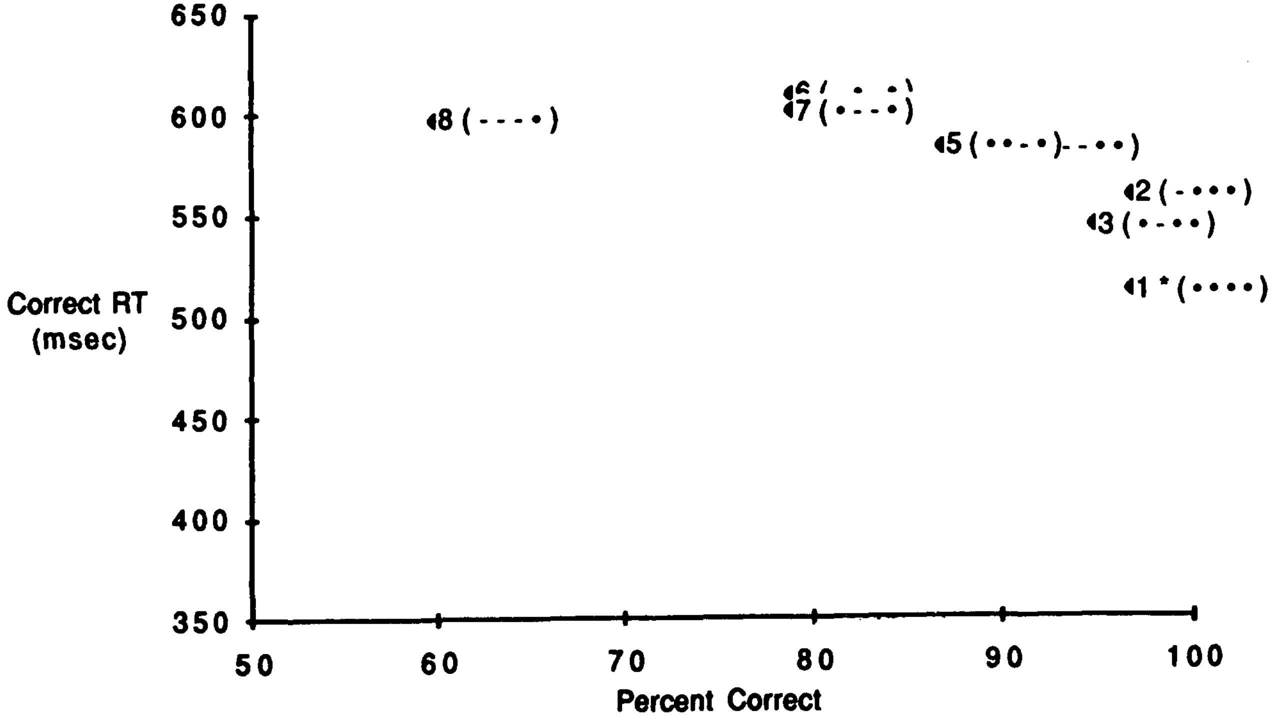
* Character rank predicted
from trace strength model

4-Element Characters with a Final "dah"



* Character rank predicted
from trace strength model

4-Element Characters with a Final "dit"



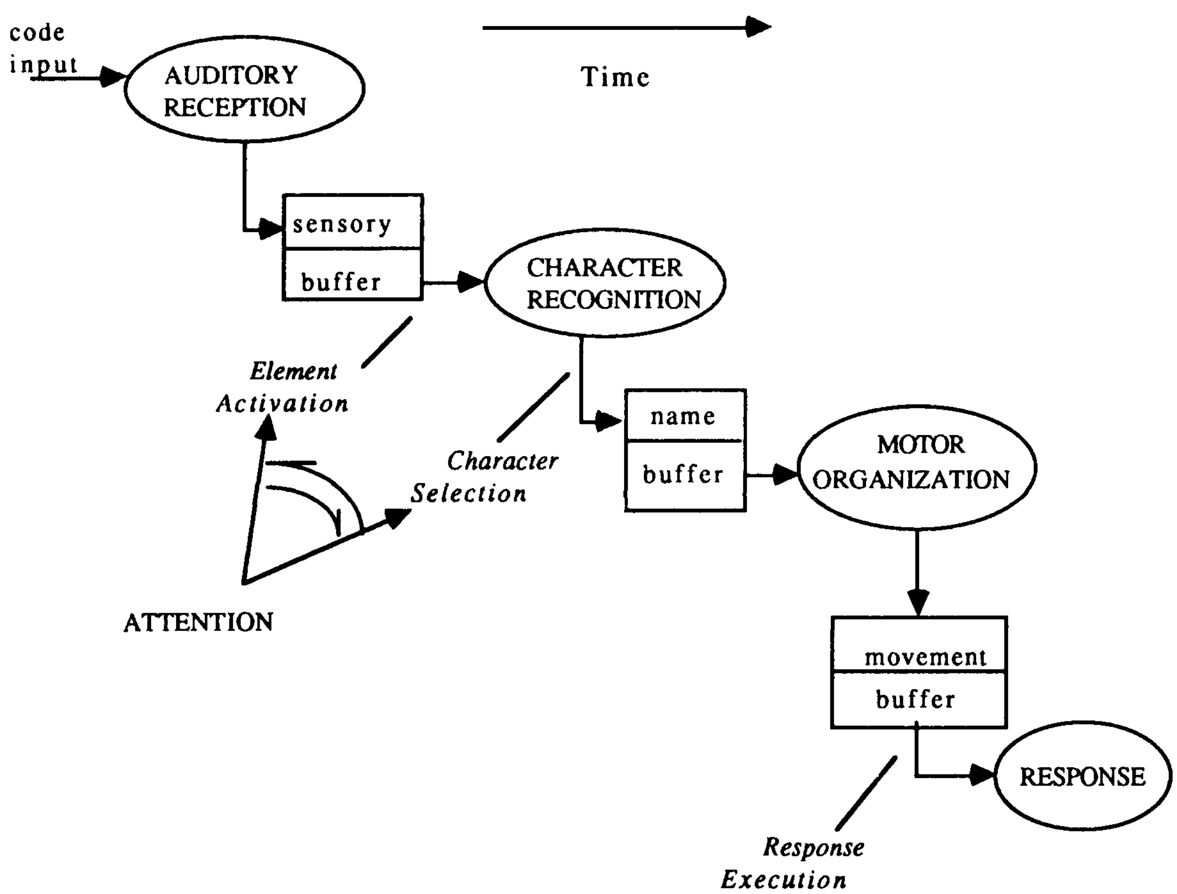
* Character rank predicted from trace strength model

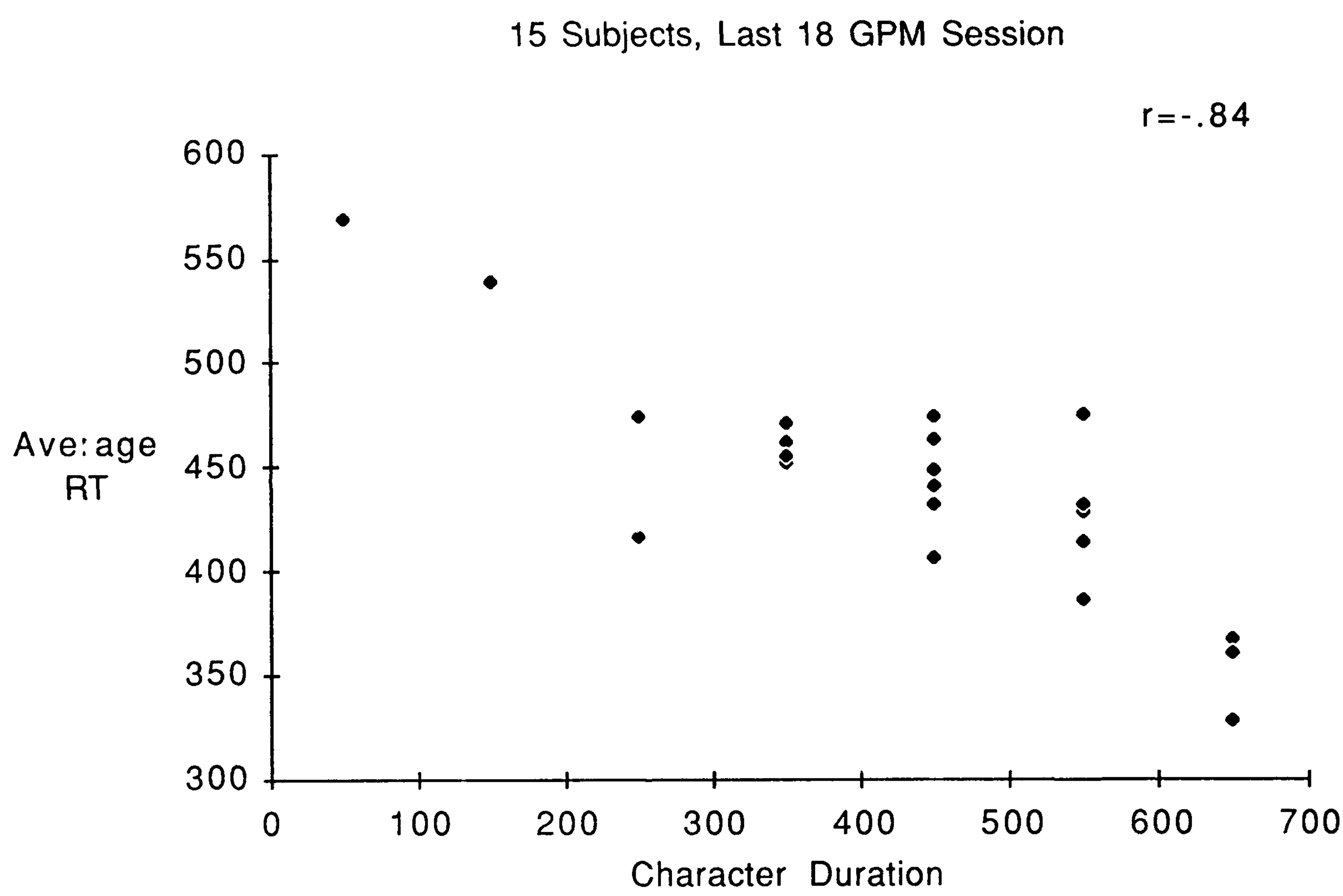
MODEL DEVELOPMENT

FEATURES OF MODEL:

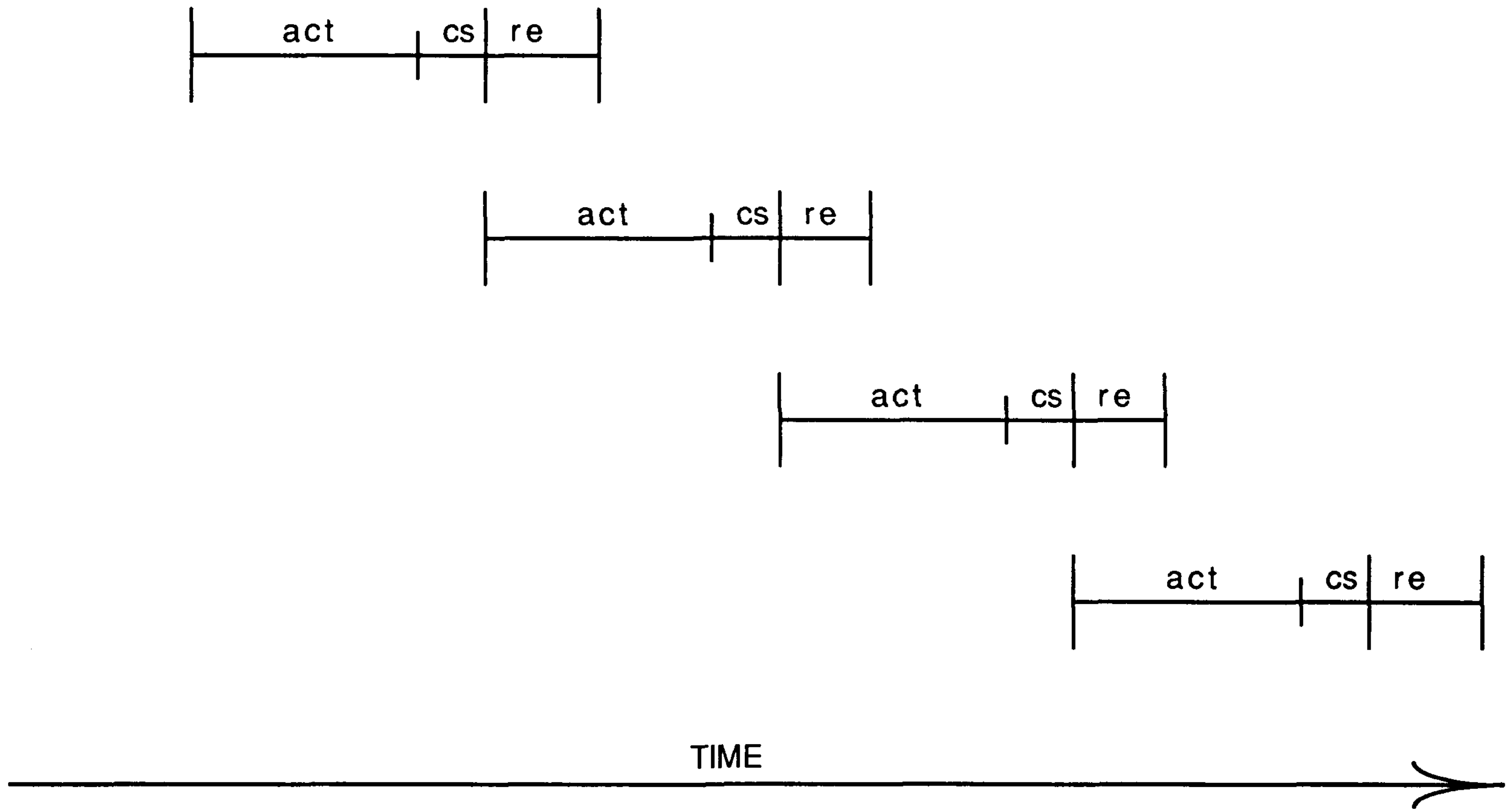
- attention shifts from previous character recognition to auditory buffer
- *Element Activation*
    - feeds information from sensory store to character recognition system
    - starts once response to previous stimulus is decided upon
    - stops after a fixed period of time (for a given speed, subject)
    - for novices, elements activated serially, earliest first (to avoid further decay)
    - for experts, all elements activated in parallel
- *Character Selection*
    - decides on character identity based upon activated information only
    - initiates response execution
- *Response Execution*
    - autonomous, proceeds without need for attention
    - attention can shift to auditory buffer for activation of next stimulus

Figure 4. Cognitive process model for skilled Morse code copying.



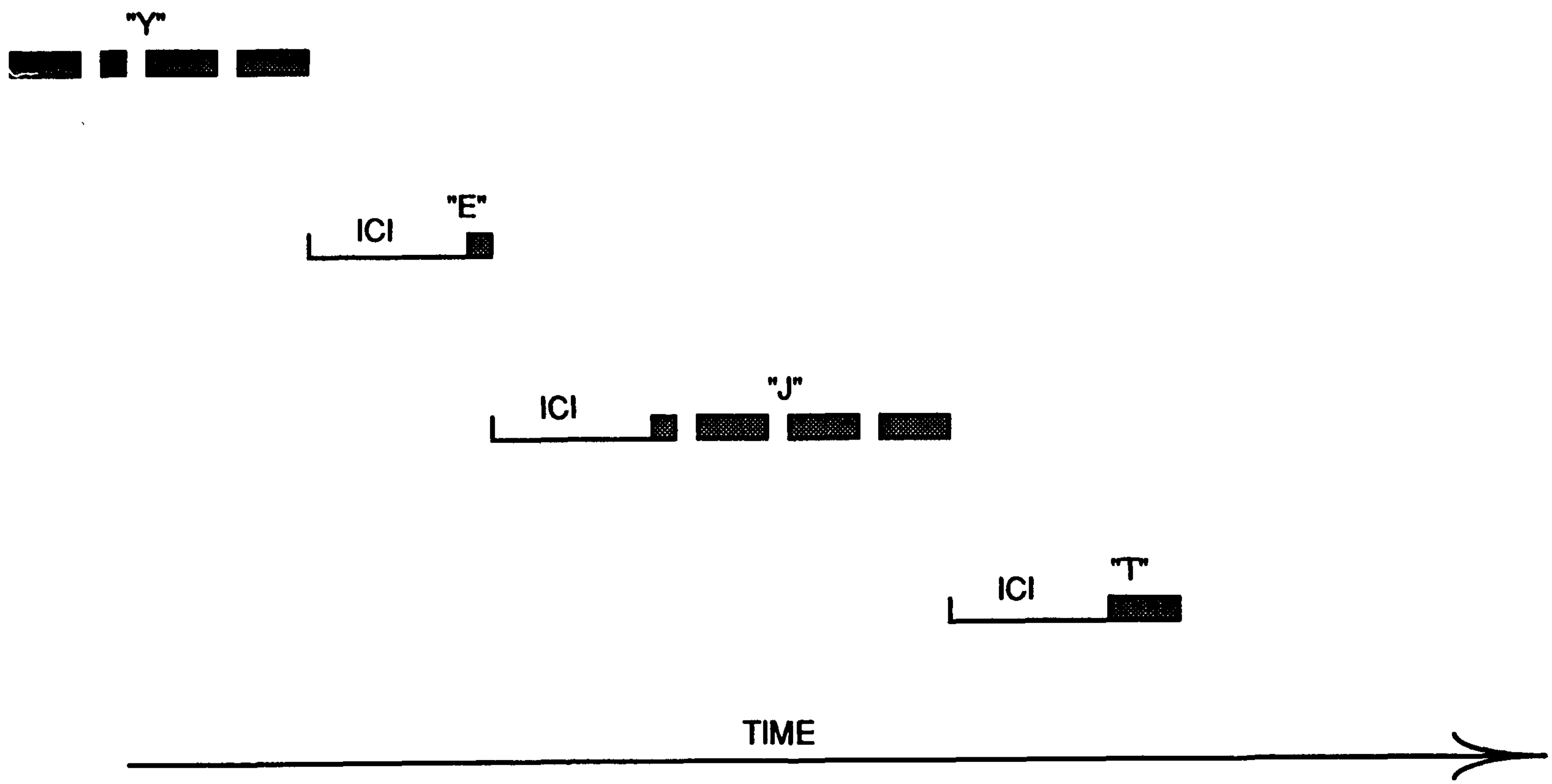

15 Subjects, Last 18 GPM Session
r=-.84
Ave:age
RT
600
550
500
450
400
350
300
0
100
200
300
400
500
600
700
Character Duration

PROCESSING SEQUENCE EXAMPLE



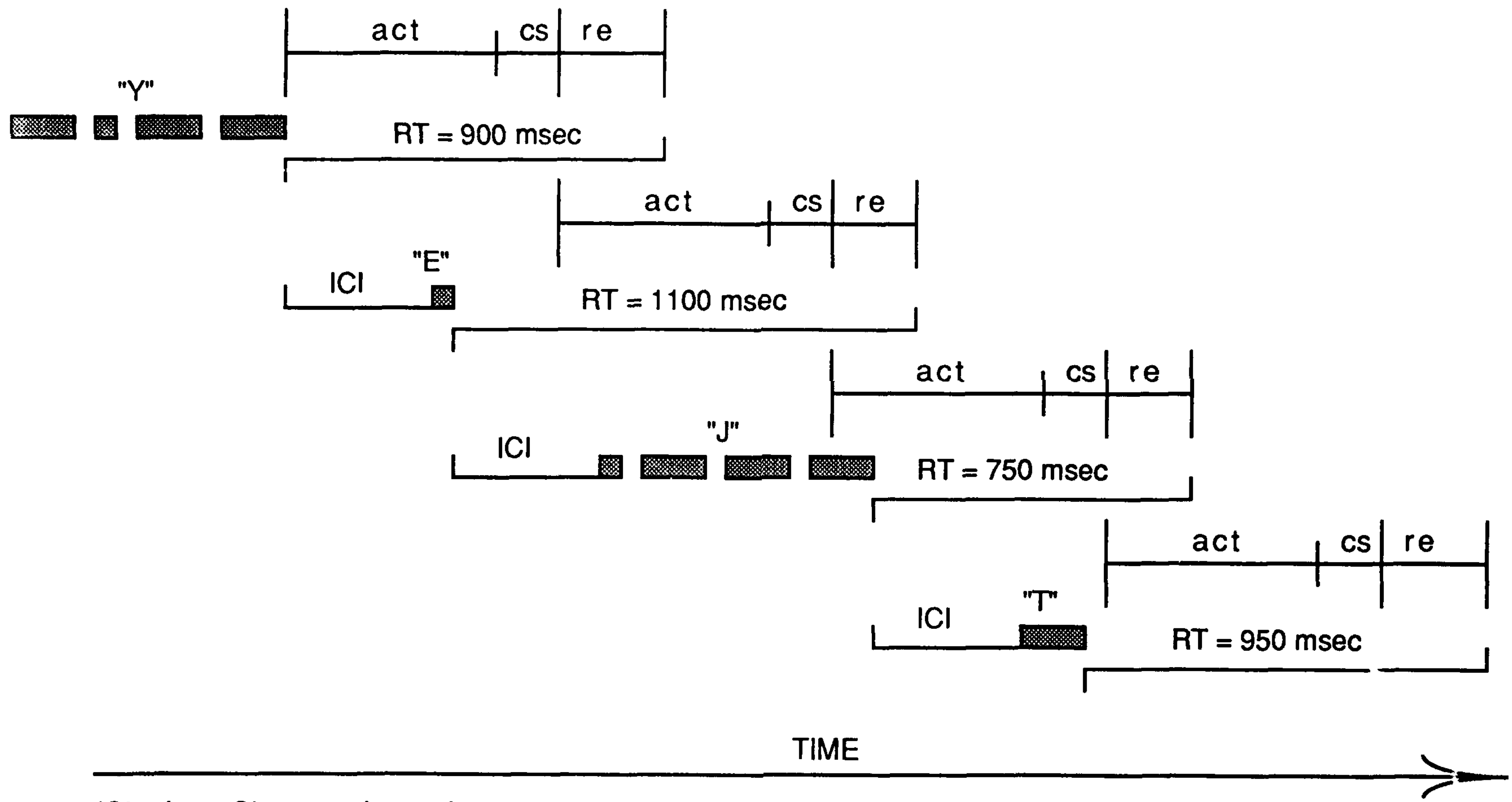
act = activation time (constant for given speed and subject, internally clocked, starts when previous cs finishes)
cs = character selection time (nearly constant, decreases with practice)
re = response execution time (variable)

STIMULUS SEQUENCE EXAMPLE



ICI = Inter-Character Interval

RESULTANT REACTION TIME SEQUENCE



ICI = Inter-Character Interval

act = activation time (constant, internally clocked, starts when previous cs finishes)
cs = character selection time (nearly constant)
re = response execution time (variable)

Figure 1. Mean Reaction Time for Each Group of Subjects at Different Presentation Speeds

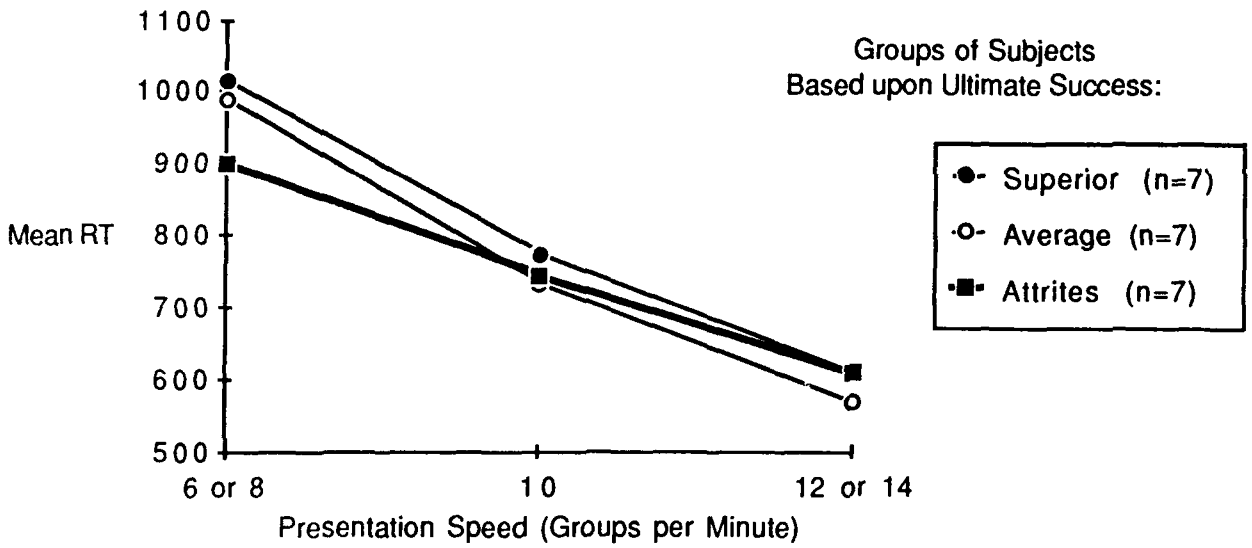
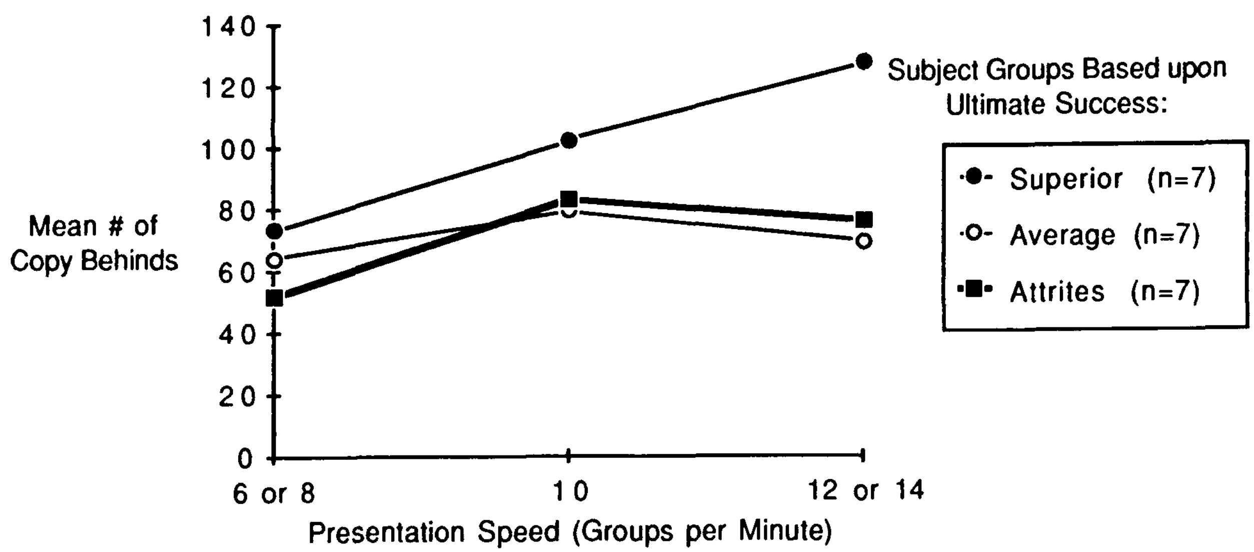


Figure 2. Mean Number of Instances of "Copying Behind" by Each Group of Subjects at Different Presentation Speeds



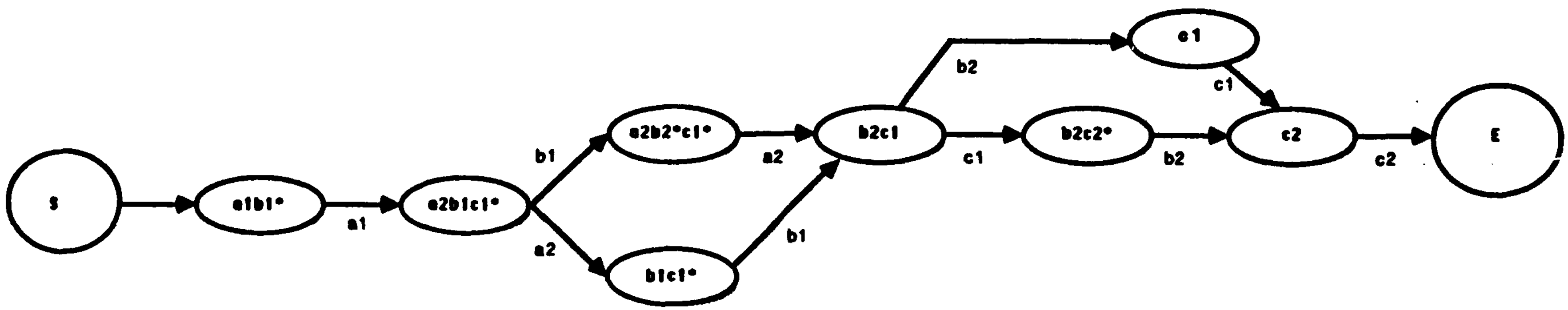


Figure 1. Diagram of the Large Start-Buffer, Upstream Blocking Model for three items.

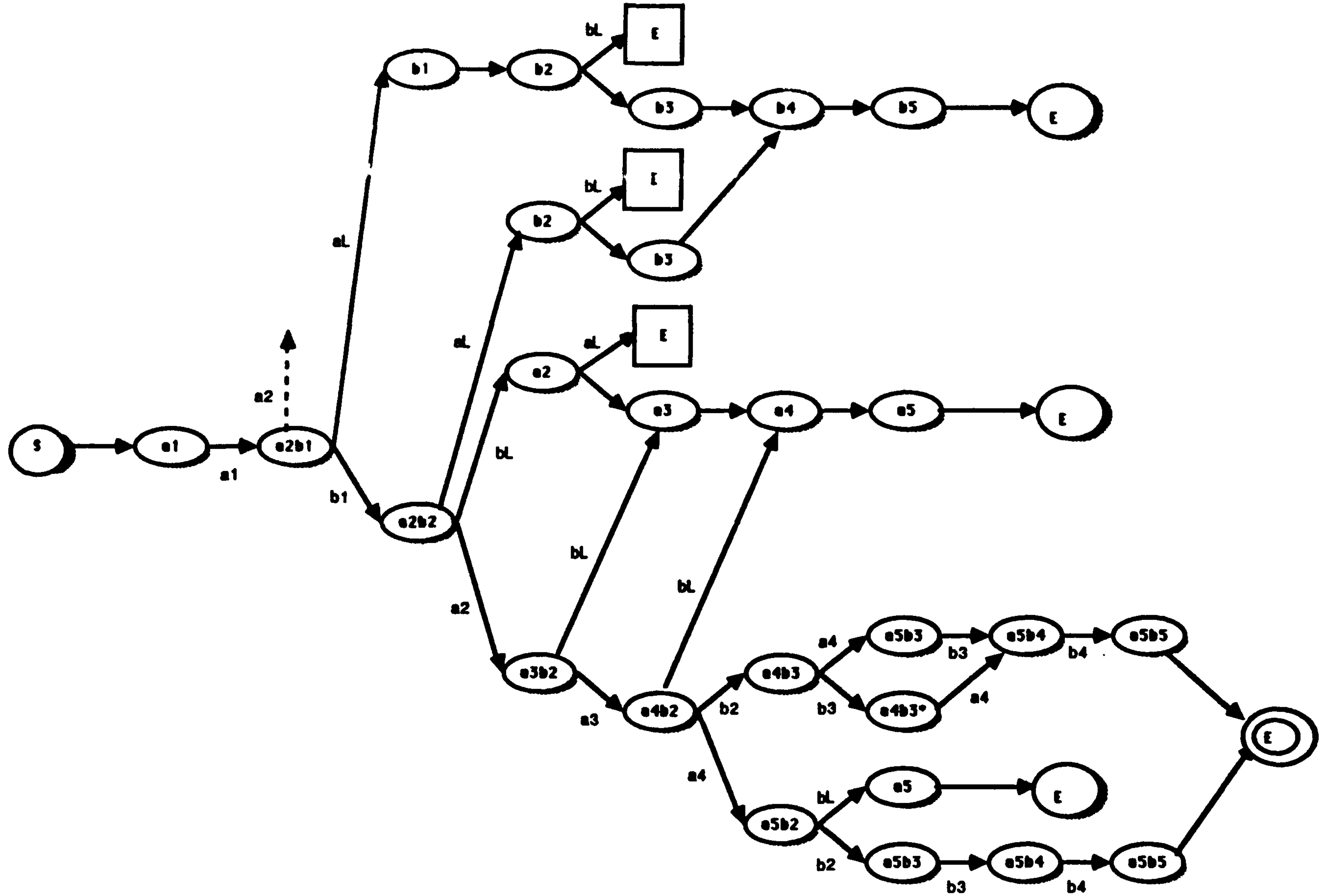


Figure 3b. Diagram of the Four Stage Model with Simultaneous Buffer Decay.

FUTURE RESEARCH IN SKILL ACQUISITION AND RETENTION

MODELS OF COLLECTIVE SKILL ACQUISITION AND RETENTION (WORK UNDERWAY)

- SYNTHETIC TRAINING ENVIRONMENTS (E.G., SIMNET)
- COGNITIVE TASK ANALYSIS OF CREWS
- GROWTH AND DECAY IN CREW PROFICIENCY

RETRAINING TIME FOR THE INDIVIDUAL READY RESERVE (WORK IN PLANNING)

- TIME TO REGAIN PROFICIENCY AFTER SEPARATION PERIODS OF 9 TO 36 MONTHS
- EMPIRICAL APPROACH THAT REQUIRES "MINI-MOBILIZATION" OF UP TO 1,000 SOLDIERS
- PREVIOUS RESEARCH ON IRR SKILL DECAY WAS UNABLE TO ASSESS RETRAINING DUE TO WAR CONTINGENCIES

RESEARCH QUESTIONS

- **How much do we remember of what we learned in secondary and post secondary classroom?**

- **What variables affect long-term retention for knowledge learned in schools?**

- **What cognitive structures and processes account for long-term retention?**

TYPES OF KNOWLEDGE AND SKILL

- Declaritive

- Procedural

- Conceptual/Contextual/Causal

RESEARCH QUESTIONS - KANSAS STUDIES

- Will PSI students learn and retain more than LFM students?

- Will retention for both groups decline over time?

- If PSI do learn more and retention does decline, will the rate of decline differ for the two groups?

- Will performance on a retention test that is the same as the end-of-course test be better than performance on a different but parallel form of the test?

- Does the amount of forgetting differ for different learning tasks?

- Does proctoring has the same effect as overlearning?

VARIABLES AFFECTING RETENTION

- **Original Learning**

- **Task Requirements**

- **Overlearning**

- **Test Conditions**

- **Retention Interval**

- **Individual Differences**

Data from PE School Study - Late 1970's

Test Version	Immediate	4 Weeks Later	6-8 Months Later	Percent Loss
I	89.28	87.61	73.08	18%
II	87.22	75.28	68.93	21%
III	89.64	79.53	70.73	21%

N= 83

Data from ASW Study - 1983

Condition	Percent Correct End of Course	Percent Correct 25 Days Later	Percent Loss
Fact	86%	78%	8%
Computation	80%	56%	24%
Gram Analysis	87%	76%	11%
Gram Classification	85%	74%	11%
Systematic Analysis	77%	61%	16%

Data from Kansas Study - 1989

Condition	Percent Correct End of Course	Percent Correct 3 Months Later	Percent Loss
PSI-S	87%	78%	10%
PSI-D		73%	16%
LD-S	76%	68%	10%
LD-D		62%	17.5%

Item Category Results from the Kansas Study - 1991

	Gains from Pretest to End of Course			
Item Category	4-month Group		11-month Group	
	X	SD	X	SD
Recognition	32.1	13.6		
Recall	48.9	21.2		
Comprehension	30.7	20.8		
Mental Skills	31.0	22.1		

	Same Form Loss - End-of-Course to End-of-Interval			
Item Category	4-month Group		11-month Group	
	X	SD	X	SD
Recognition	-13.7	12.7	-18.7	11.7
Recall	-25.0	20.6	-28.3	19.2
Comprehension	-12.7	16.6	-15.3	17.1
Mental Skills	-13.7	18.1	-18.7	15.8

	Different Form Loss - End-of-Course to End-of-Interval			
Item Category	4-month Group		11-month Group	
	X	SD	X	SD
Recognition	-16.9	14.2	-20.2	10.8
Recall	-27.9	25.4	-36.2	20.8
Comprehension	-18.6	18.9	-16.9	18.8
Mental Skills	-17.9	21.0	-21.3	23.4

SUBGROUP SESSION III

ADVANCED TRAINING TECHNOLOGY

Basic Job Skills Job Family Tutor:
Dr. Ellen Hall

Issues in Designing and Intelligent,
NLP-based Tutor for Foreign Languages:
Dr. Michelle Sams

Basic Job Skills
Job Family Tutor

AIR FORCE SYSTEMS COMMAND

Dr. Ellen Hall
AL/HRMJC

OVERVIEW

History of BJS Program

Research Problem

BJS Goals

Approach

Tutoring Single Jobs vs. Job Families

Job Family Tutor Learning Study

Illustration of JFT Instruction

Payoffs

CHRONICLE OF SIGNIFICANT EVENTS

- CY 88: Successful field test of prototype Avionics Troubleshooting Tutor
- Mar 88: Request from TAC/LG (MGen Vicellio) to AFSC/XT (BGen Stebbins) to accelerate BJS effort
- CY 89: TAC Day briefing to AFSC/CC (Gen Randolph) and TAC/CC (Gen Russ) and staff
- Dec 89: MOU signed by TAC/LG (MGen Logeman) and AFSC/XT (MGen Ferguson) for continued support of BJS R&D
  - included authorizations for two F15 avionics technicians for BJS in-house team
  - allows access to maintenance personnel at F15/16/111 flying units

ADVOCACY FOR BJS PROGRAM

"We consider this a crucial research project with tremendous payback potential in the aircraft maintenance training area."

MGen Henry Viccelio, Jr TAC/LG

to

BGen Charles Stebbins AFSC/XT

March, 1988

CHRONICLE OF SIGNIFICANT EVENTS
(Cont'd)

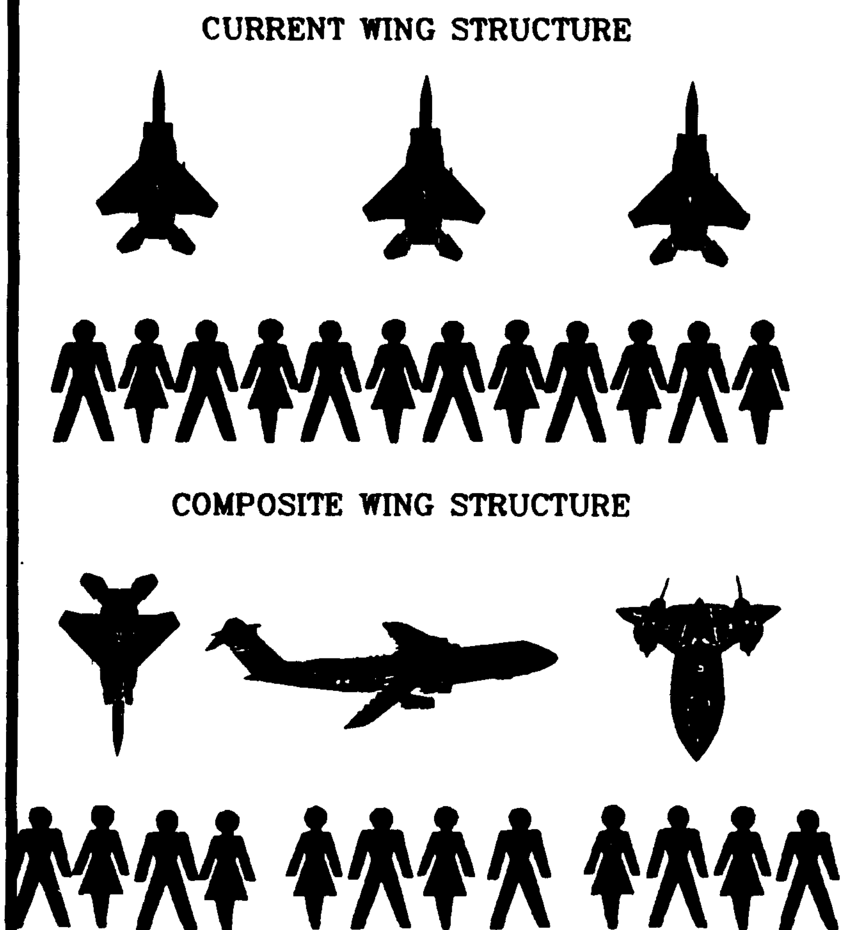
- CY 89-90: TAC funded $26.1M FY92 initiative for FSD of F15 and F16 troubleshooting tutors
  - OPR: HSD/YA and XR
- Dec 90: Demo of refined tutor given to CSAF (Gen McPeak) and AFSC/CC (Gen Yates) as part of new CSAF's orientation to AFSC
- Jan 91: TAC Day demo of refined tutor given to TAC/CC (Gen Russ) and AFSC/CC (Gen Yates), Andrews AFB MD

THE PROBLEM

- Becoming competent in technologically complex environment
- Countering the negative effects of machine capabilities

... lost apprenticeship

THE PROBLEM



- Becoming competent in technologically diverse environments
- Accomodating new force structure and force downsizing

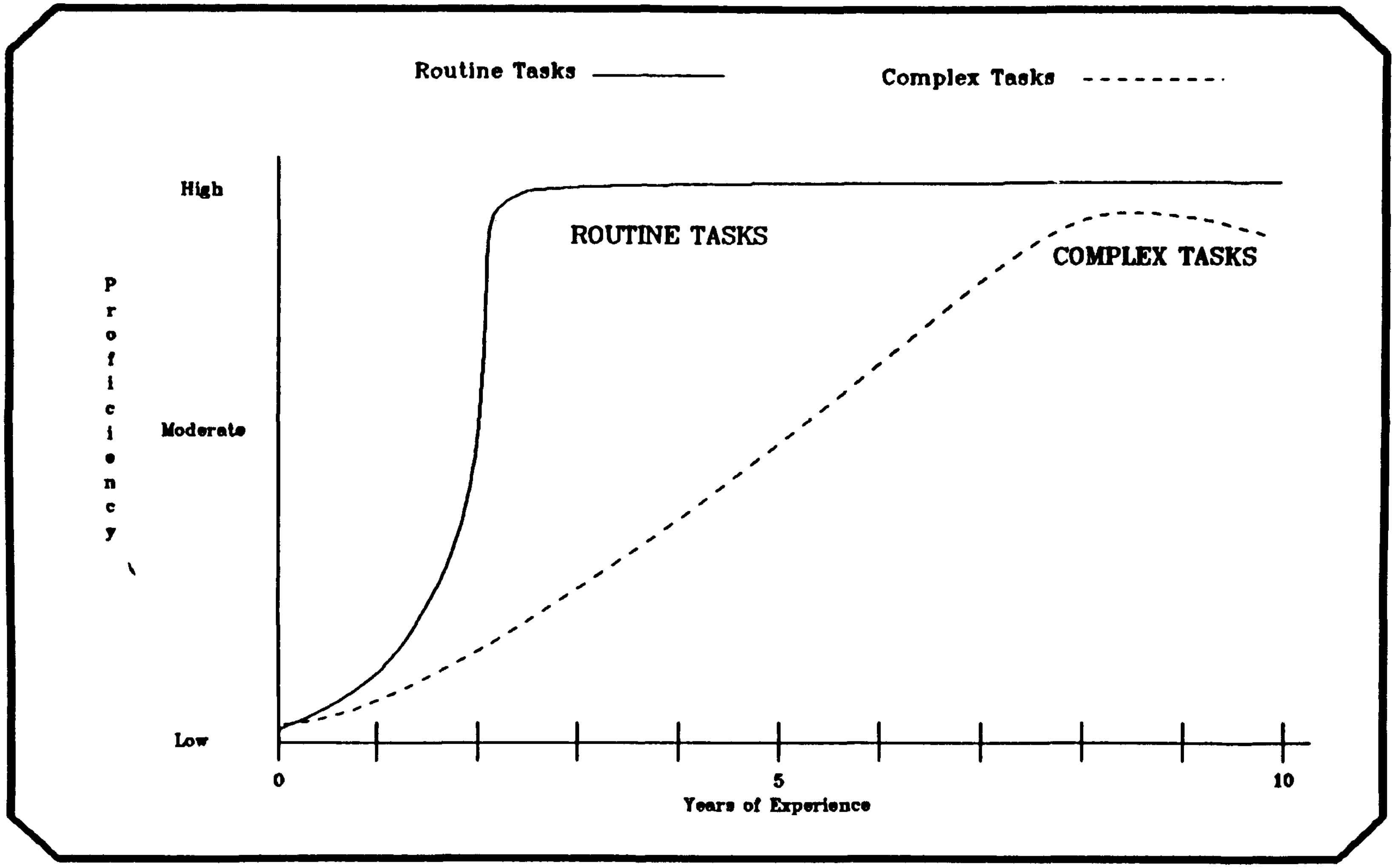
... **Fostering Adaptive Expertise**

BASIC JOB SKILLS GOALS:

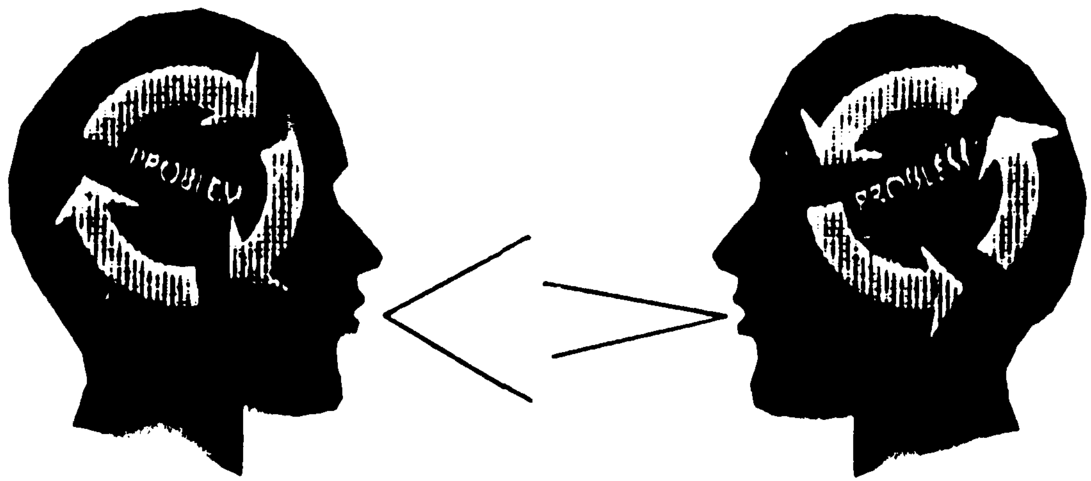
HIGH-TECH COMPETENCE DEFINITIONS AND COMMONALITIES → TESTING/TRAINING WITH FOCUS ON HIGH-TECH PROBLEM SOLVING → RESTORED APPRENTICESHIP

TESTING/TRAINING WITH FOCUS ON HIGH-TECH PROBLEM SOLVING → ADAPTIVE EXPERTISE

COMPLEX SKILLS

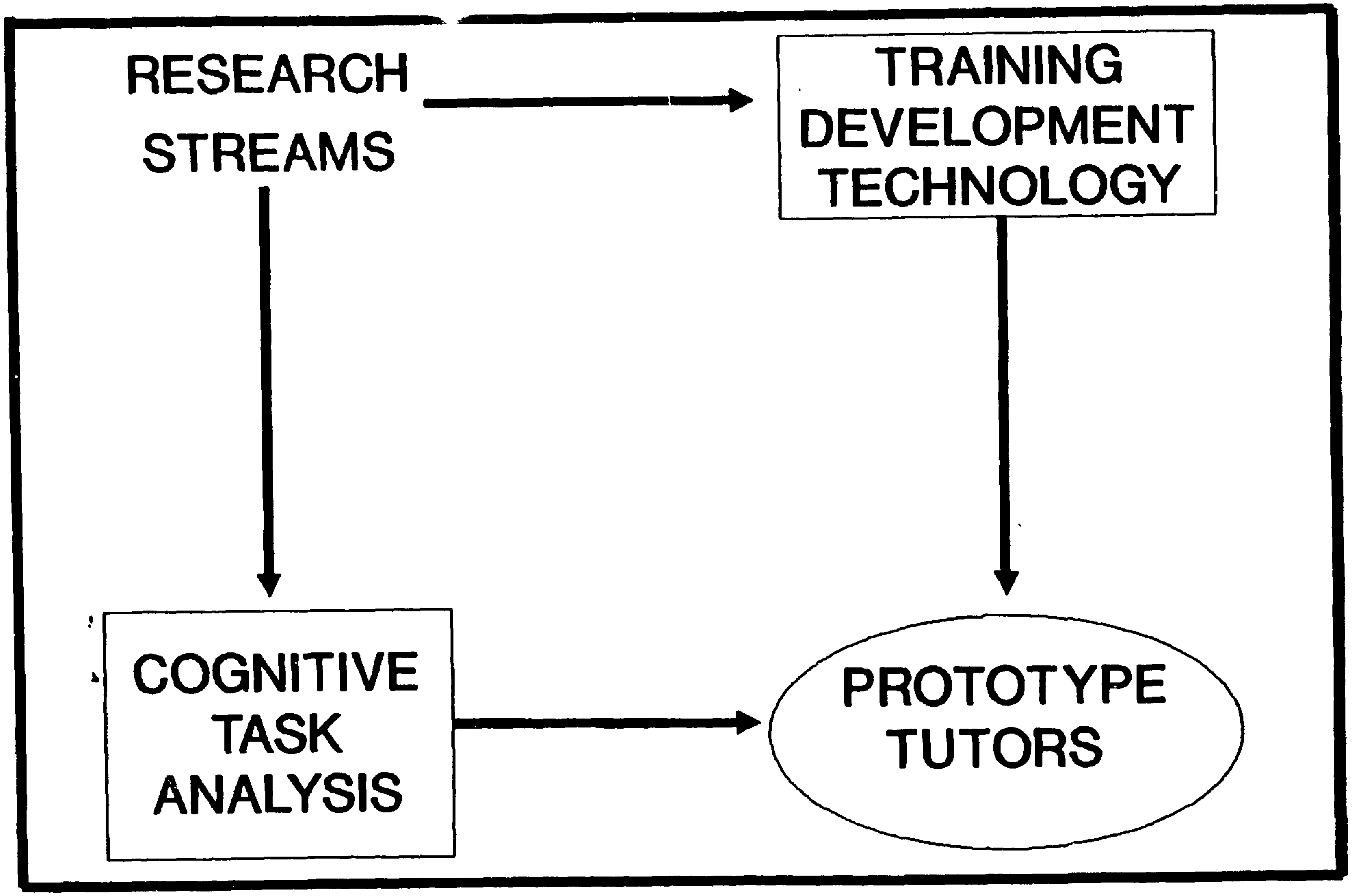


APPROACH



- THEORIES OF EXPERT PROBLEM SOLVING
- PROCEDURES BASED ON ADVANCES IN ARTIFICIAL INTELLIGENCE TO SPECIFY HOW EXPERTS SOLVE PROBLEMS — *COGNITIVE TASK ANALYSIS TECHNOLOGY*
- PROCEDURES BASED ON PRINCIPLES OF APPRENTICESHIP TRAINING TO TURN EXPERT KNOWLEDGE INTO LEARNABLE CONTENT FOR TRAINING — *TRAINING DEVELOPMENT TECHNOLOGY*

R&D APPROACH

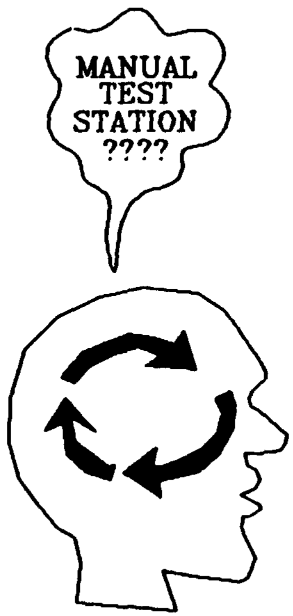


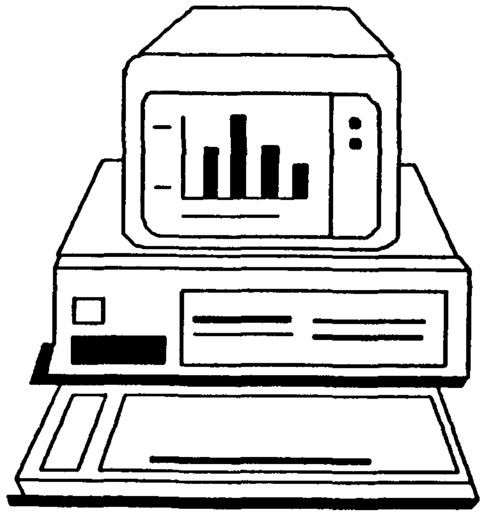
RESEARCH STREAMS
TRAINING DEVELOPMENT TECHNOLOGY
COGNITIVE TASK ANALYSIS
PROTOTYPE TUTORS

BJS TECHNOLOGIES

- Cognitive Task Analysis (CTA) Technology
- Training Development Technology (TDT)
- Prototype Troubleshooting Tutors
  - Single Job Tutors
  - Job Family Tutors

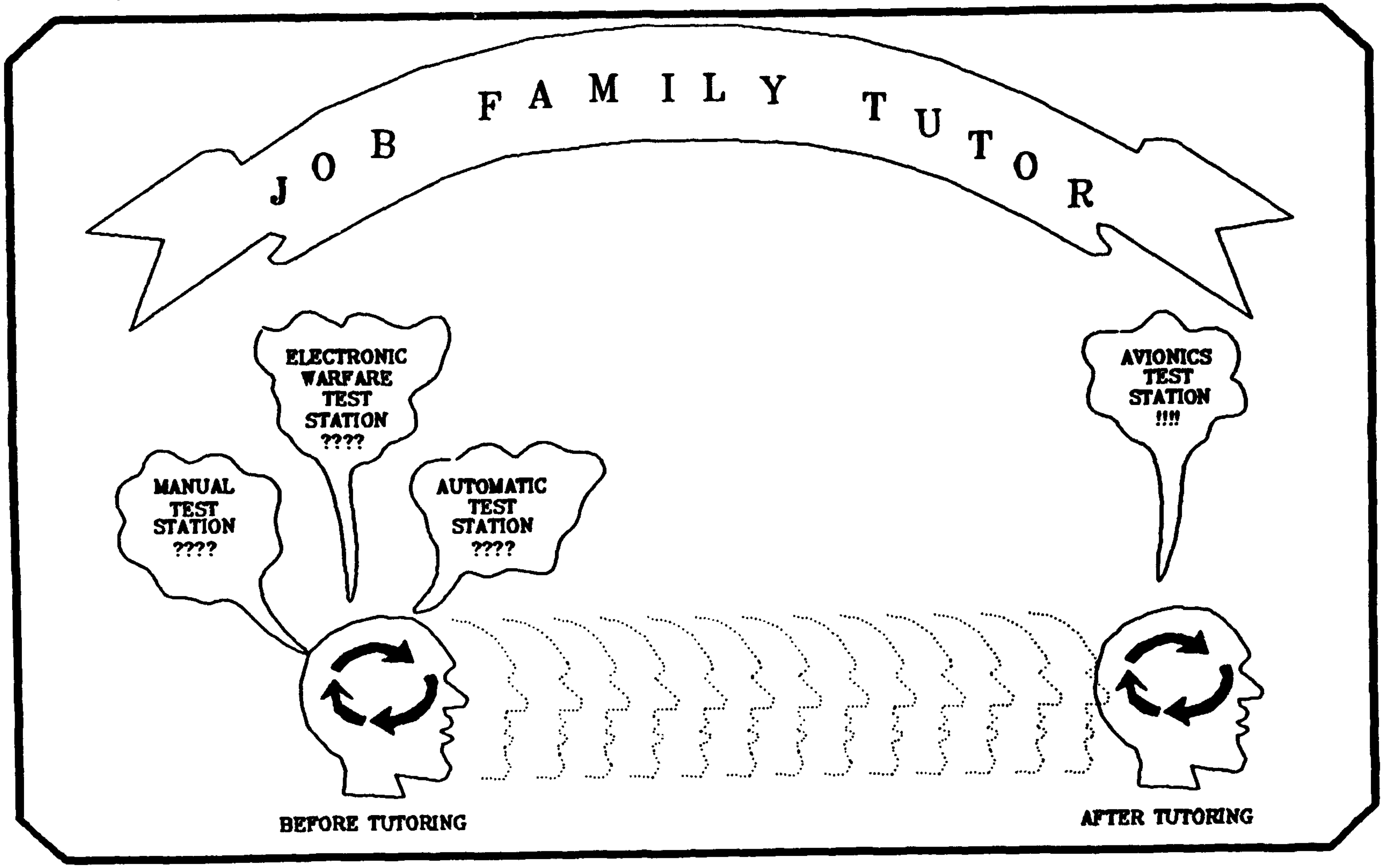
SINGLE JOB TUTOR



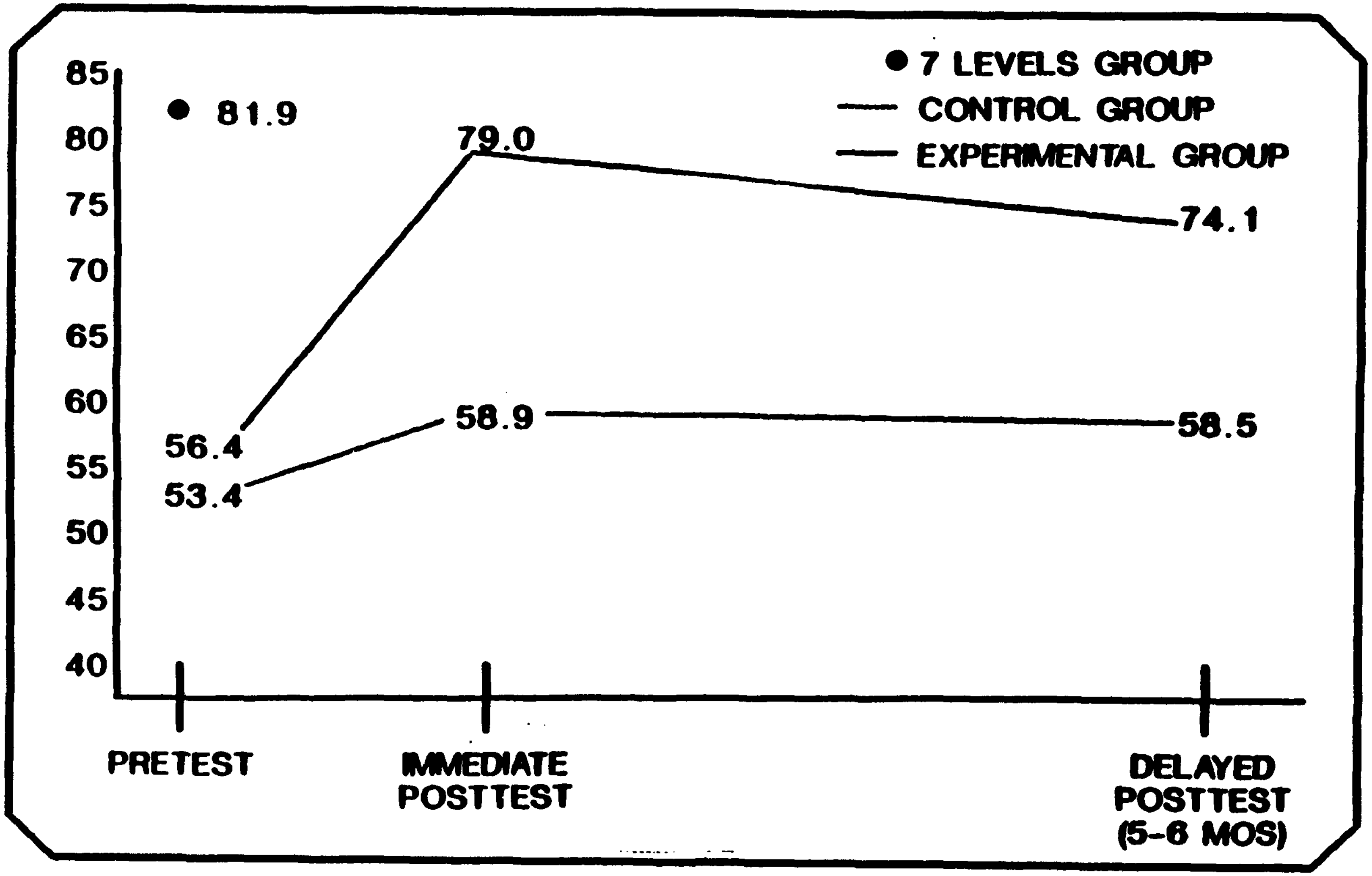


- TROUBLESHOOTING SCENARIOS
- COACHING
- TRAINEE EVALUATION

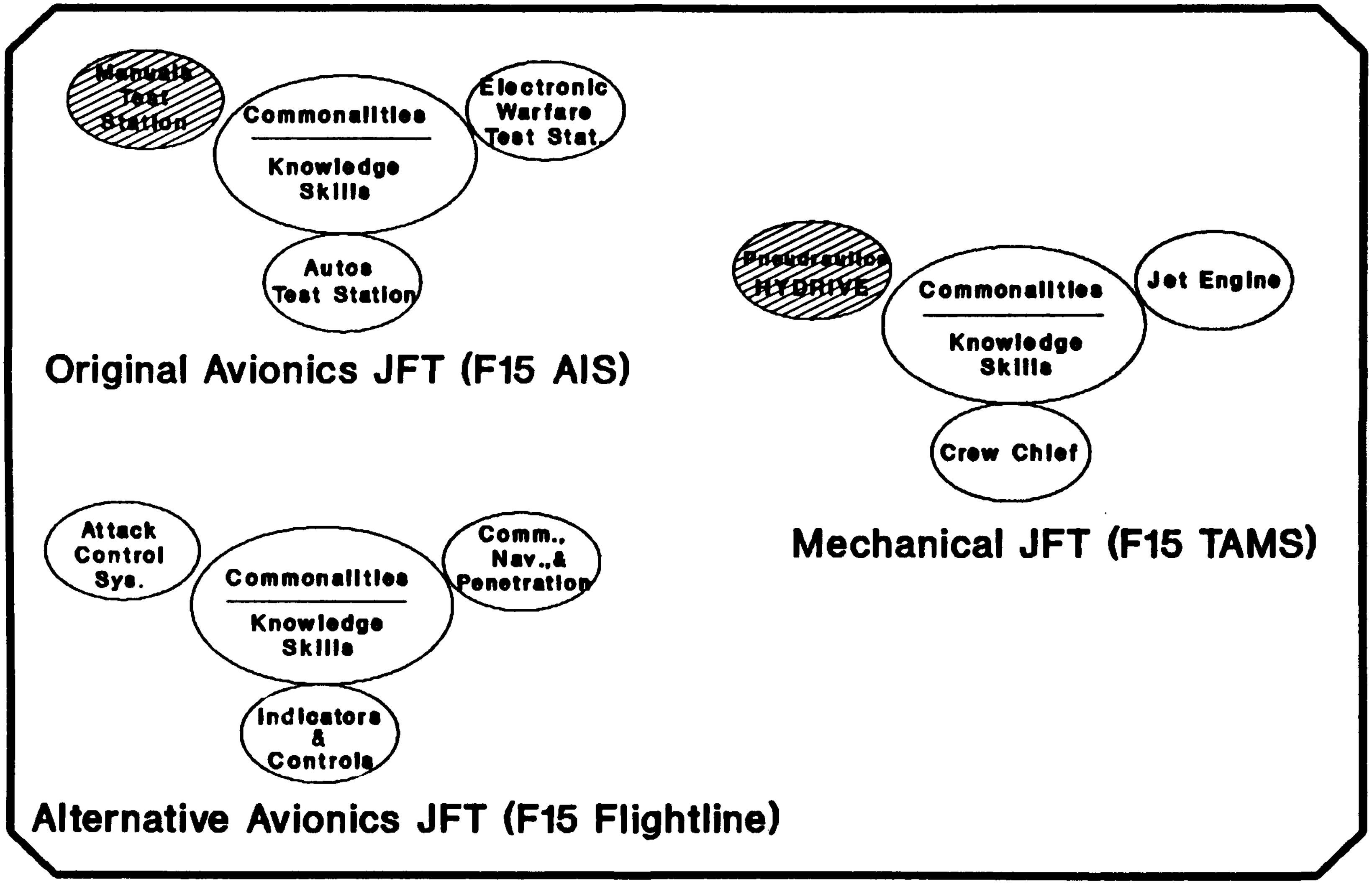
FOSTERING ADAPTIVE EXPERTISE



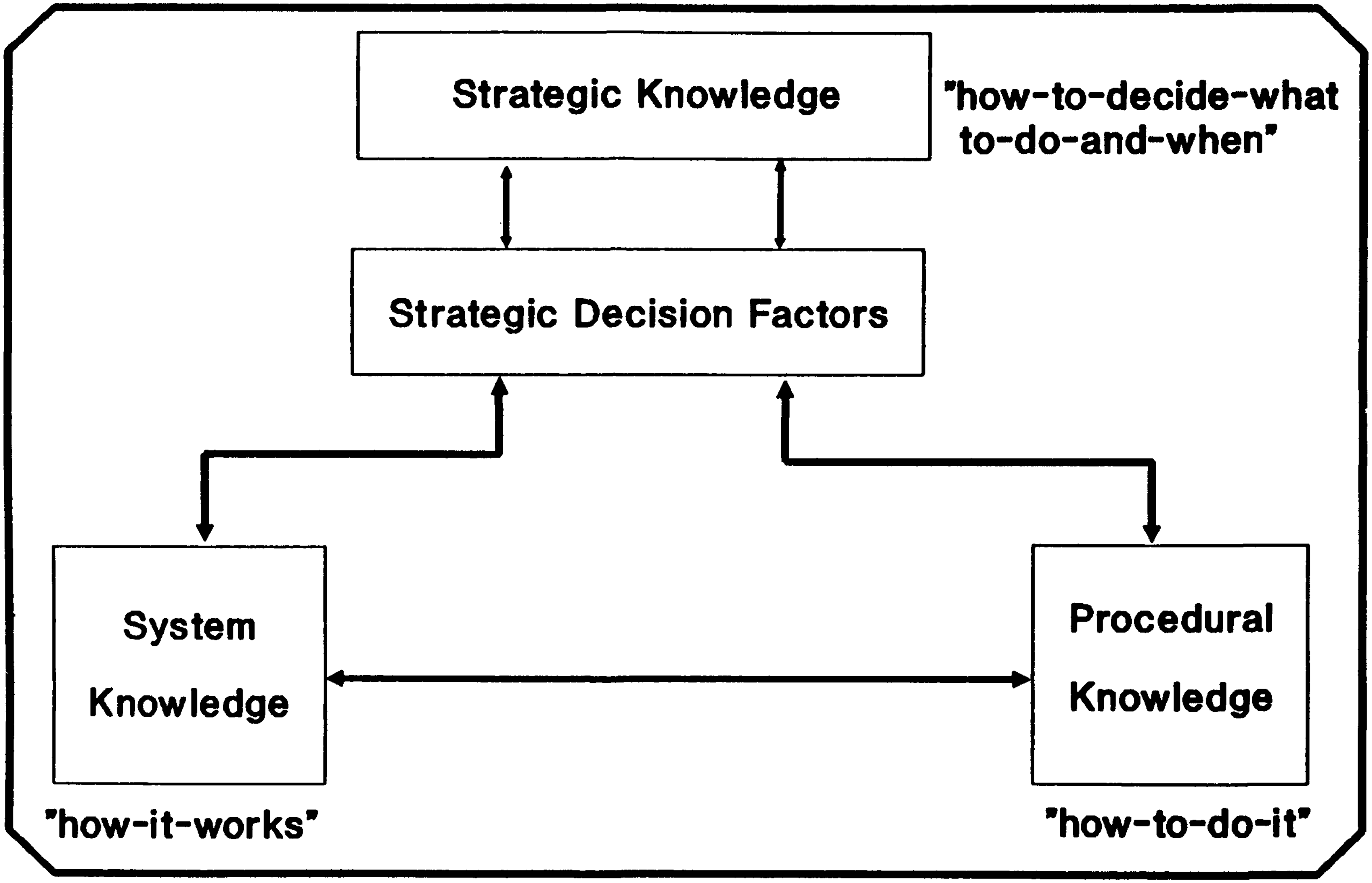
EVALUATION RESULTS:
AVIONICS TROUBLESHOOTING TUTOR (SJT)



PROPOSED JOB FAMILY TUTORS



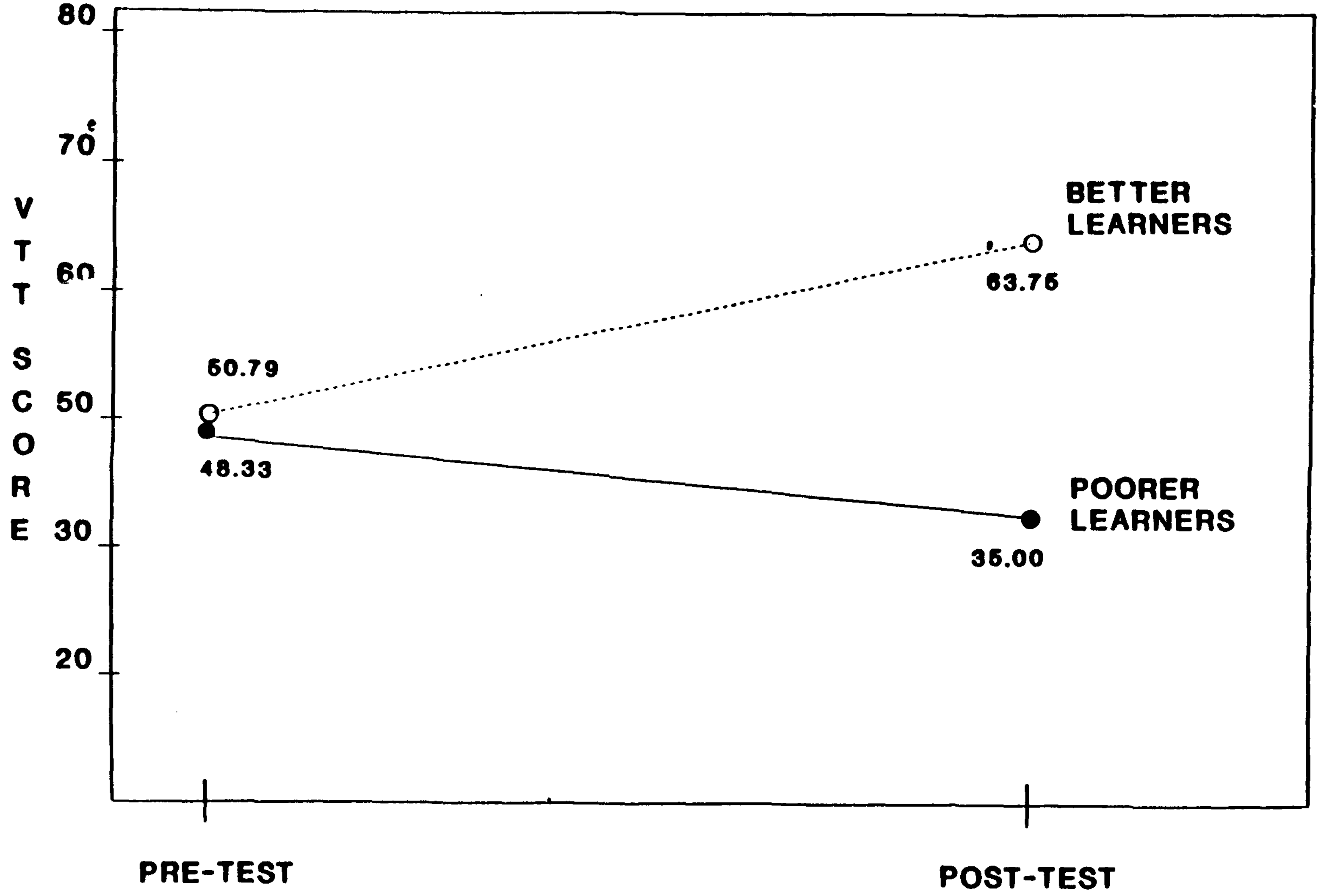
COGNITIVE SKILL COMMONALITIES



AVIONICS JFT LEARNING STUDY
49TH TFW--HOLLOMAN AFB NM

- Six Rivet trainees into EWS job participated
  - Tech School
  - OJT
  - Experience range
- Pre-posttest scored by verbal troubleshooting procedure
- Six hours of one-on-one tutoring by EWS expert
- Effect on performance
  - Four technicians improved
  - Two technicians regressed

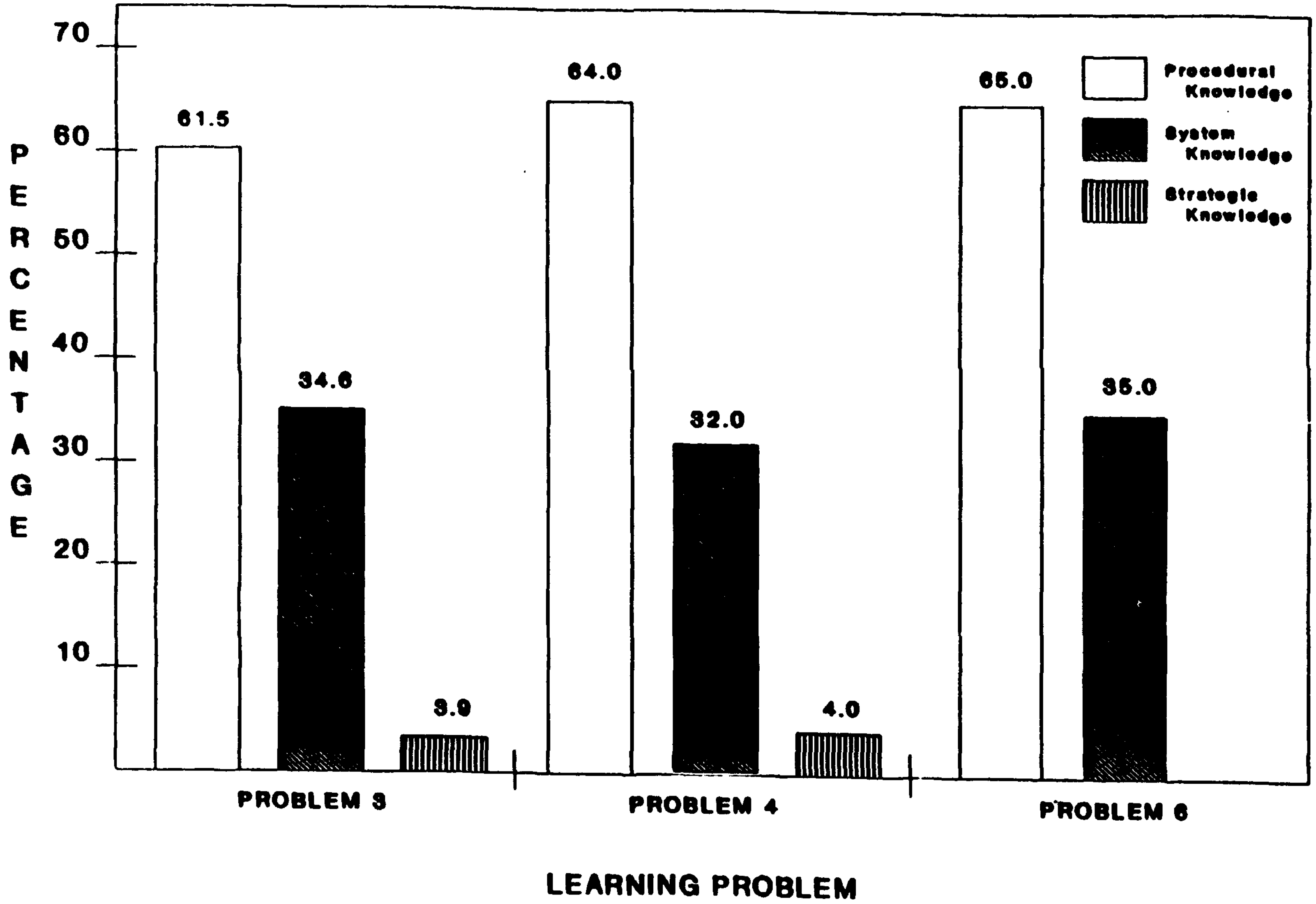
AVERAGE PRE- AND POST-TEST SCORES
BETTER LEARNERS VS. POORER LEARNERS

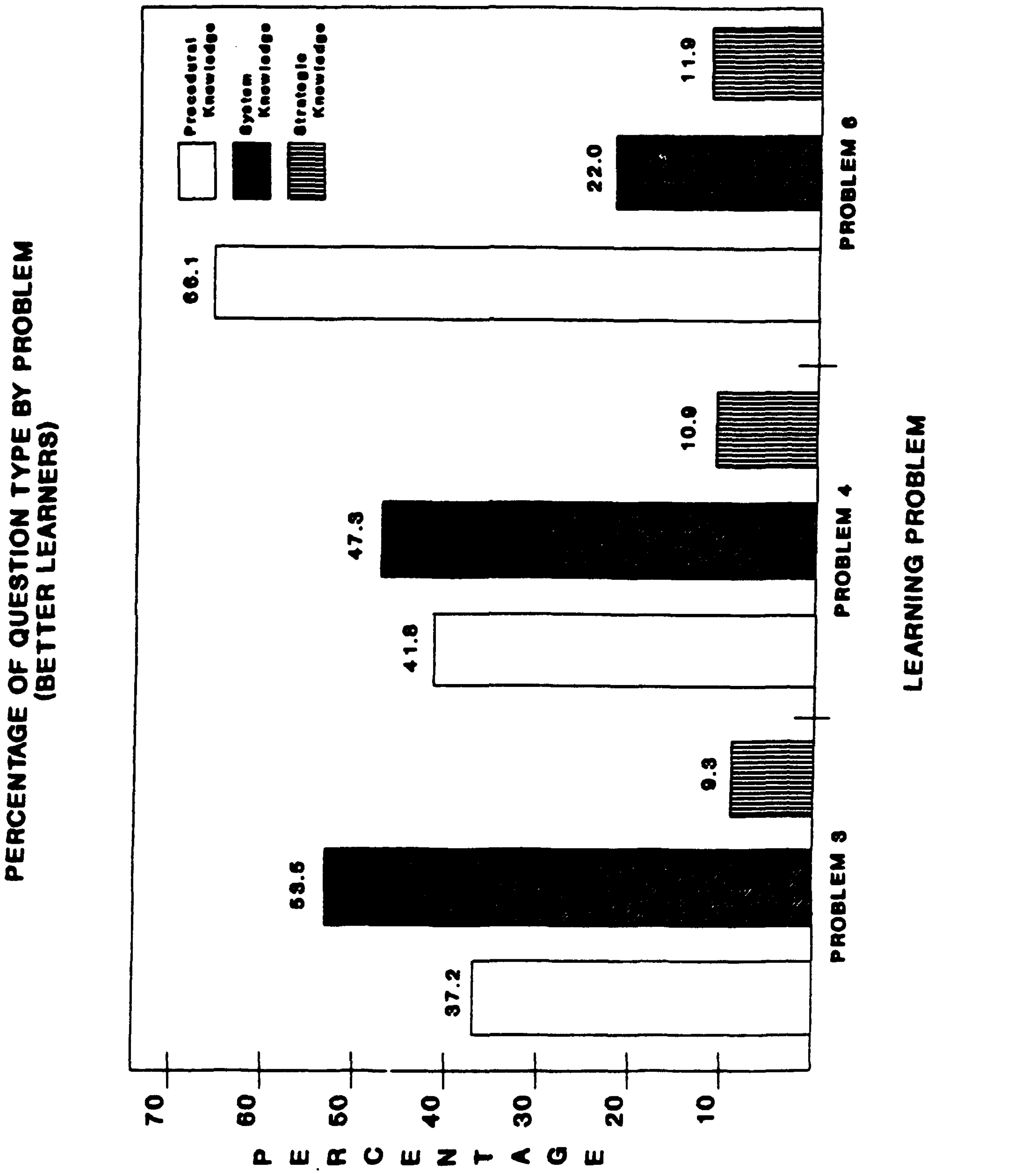


SAMPLING OF QUESTIONS

Procedural Knowledge	"I need to find an easy spot on the Lower 16 card to pick off the signal." "How do you actually use the general maintenance program?
System Knowledge	"I know all the station resources that are being used, but I don't know how." "Could the RF Counter be called a Microwave Frequency Counter?"
Strategic Knowledge	"Is there another way to split the path to see if I'm getting the signal, besides measuring off the relays?" "For practical purposes, is it generally easier to leave the LRU test set up and take a measurement off the MSS to verify the output?"

PERCENTAGE OF QUESTION TYPE BY PROBLEM
(POORER LEARNERS)





PERCENTAGE OF QUESTION TYPE BY PROBLEM
(BETTER LEARNERS)
PERCENTAGE
70
60
50
40
30
20
10
37.2
53.5
9.3
41.8
47.3
10.9
66.1
22.0
11.9
PROBLEM 3
PROBLEM 4
PROBLEM 6
LEARNING PROBLEM
Procedural Knowledge
System Knowledge
Strategic Knowledge

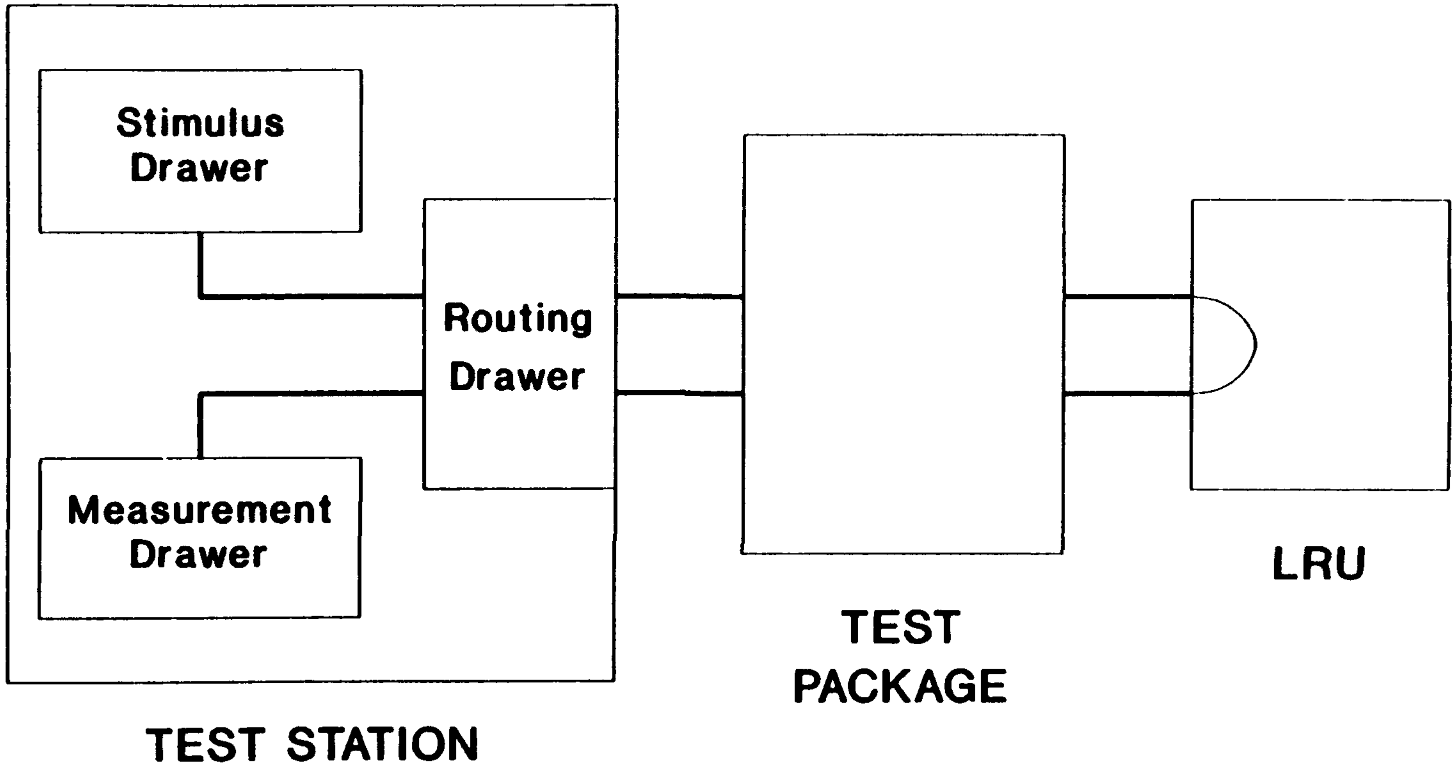
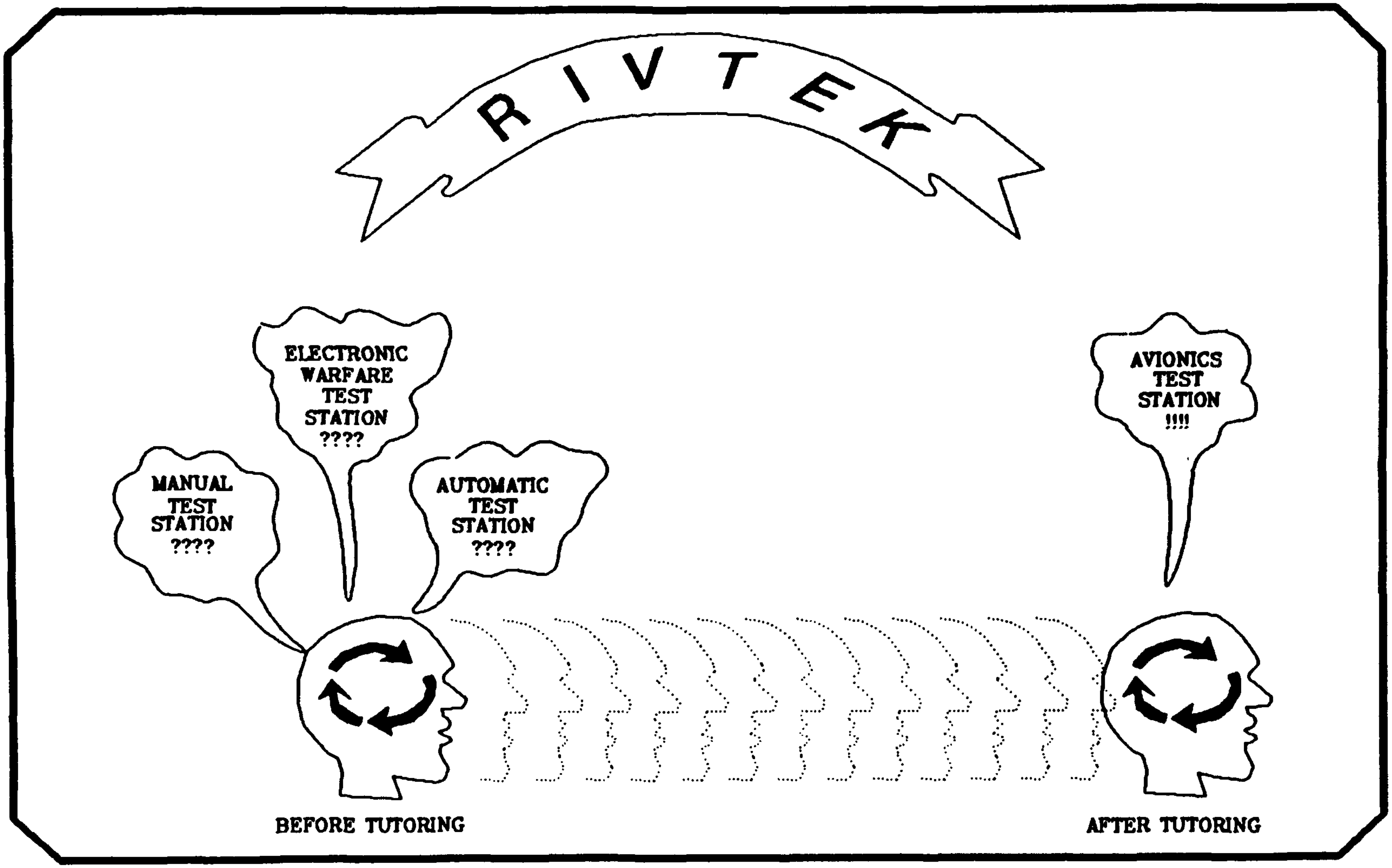


Figure 6. General Equipment Configuration During LRU Testing

ILLUSTRATION OF JFT INSTRUCTION

FOSTERING ADAPTIVE EXPERTISE



RIVTEK

ADAPTIVE EXPERTISE

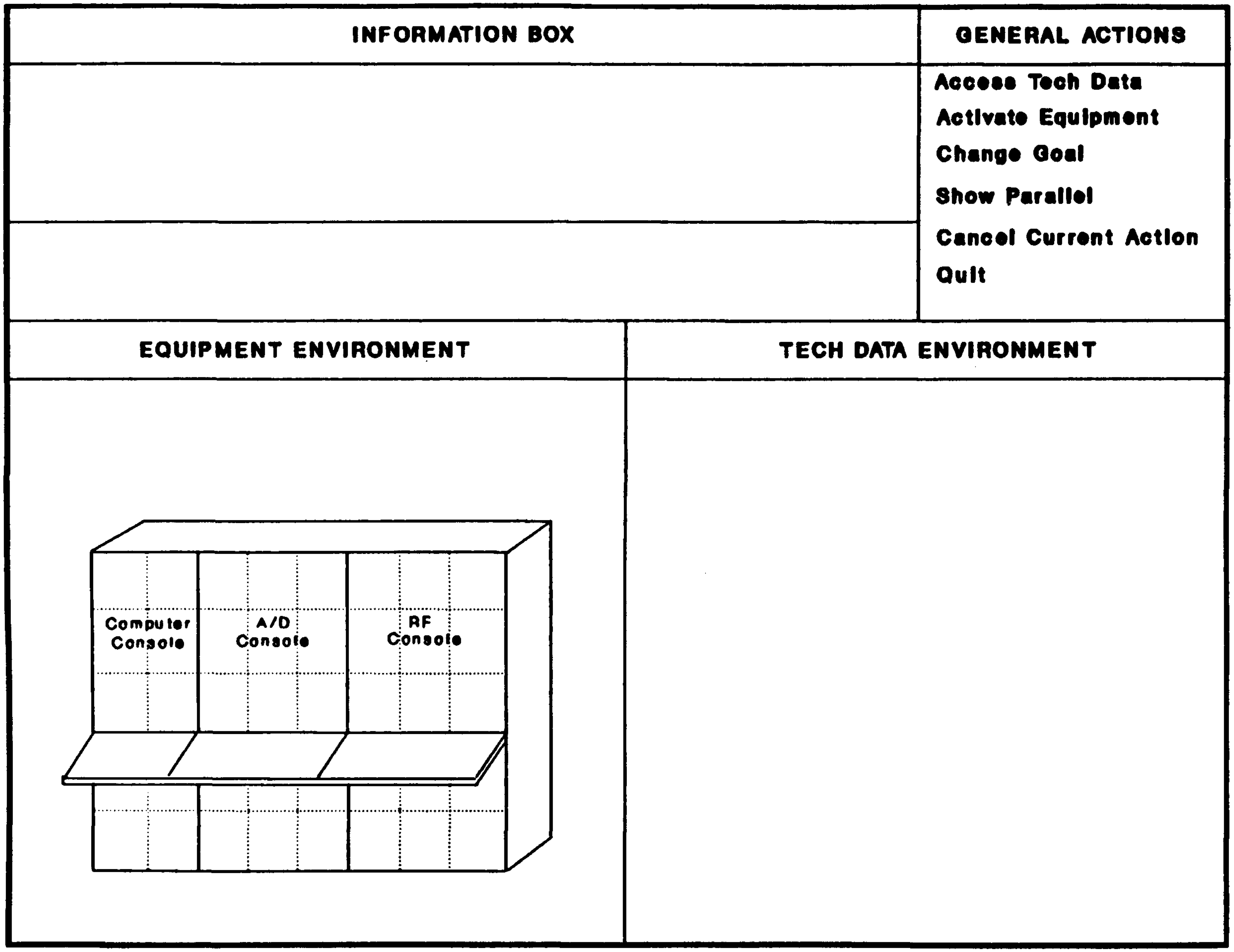
INTRODUCTION

In RIVTEK you will be challenged to become a better troubleshooter on avionics equipment that is similar, but not identical, to the equipment on which you received your primary AF technical training. You will be presented a series of increasingly difficult troubleshooting scenarios to advance your fault isolation skills on the TEWS Intermediate Test Equipment (TITE). In addition, RIVTEK is equipped to strengthen your troubleshooting and learning skills in general. As a consequence, you can significantly increase your adaptiveness as a technician on multiple avionics systems -- even on systems that are yet to be fielded, e.g., avionics systems on the ATF.

RIVTEK

ADAPTIVE EXPERTISE

In the course of working through RIVTEK's scenarios, you will be evaluated at various points along the way. Performance indicators will gauge the following: (a) your increasing skill in troubleshooting the TITE station, (b) your growing <u>independence</u> from RIVTEK's coaching, and (c) your general adaptiveness across different avionic systems. Your goal is to take full advantage of RIVTEK's coaching and other explanatory resources to become a skilled, adaptive technician with improved "mental tools" for thinking about and solving hard electronic failures on any piece of equipment. As a final RIVTEK evaluation, you will be presented scenarios on a system that is entirely novel to you.


INFORMATION BOX
GENERAL ACTIONS
Access Tech Data
Activate Equipment
Change Goal
Show Parallel
Cancel Current Action
Quit
EQUIPMENT ENVIRONMENT
TECH DATA ENVIRONMENT
Computer Console
A/D Console
RF Console

INFORMATION BOX

The Tactical Electronic Warfare System (TEWS) Intermediate Test Equipment (TITE) is a semi-automatic test station. It is used to test components of the F-15's Electronic Countermeasures (ECM) system. It consists of three sections: (1) the Computer Console which is used to control the test station; (2) the Analog/Digital Console which processes signals below radio frequency; and (3) the Radio Frequency Console which processes RF signals. To ensure the test station is operating correctly it is tested periodically. These tests, called Operational Assurance/ Fault Isolation (OA/FI), test each device in the test station; if one fails, ~~it~~ must be repaired before an ECM component can be tested by the test station.

INFORMATION BOX

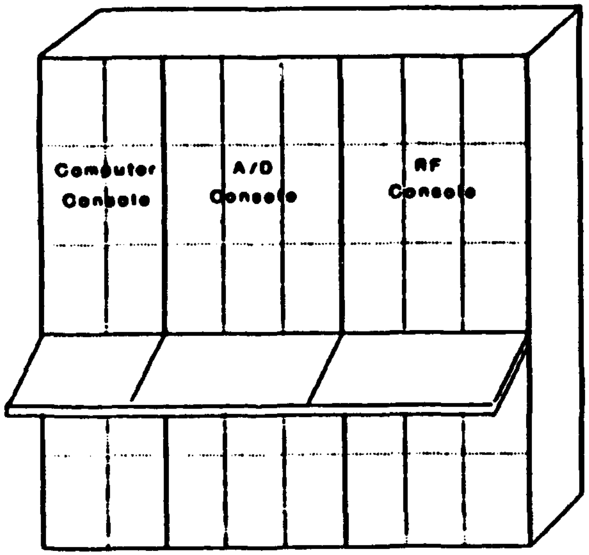
YOU ARE PERFORMING THE OPERATIONAL ASSURANCE AND FAULT ISOLATION (OA/FI) TESTS ON THE TEWS INTERMEDIATE TEST EQUIPMENT (TITE) AS PART OF ITS WEEKLY MAINTENANCE INSPECTION. YOU HAVE INSTALLED THE PROPER SOFTWARE AND HAVE BEGUN TESTING. THE TEST STATION HAS REPORTED A FAIL AT OAFI SEGMENT P2 T10 S620 D1 M01 AND YOU MUST TROUBLESHOOT THE MALFUNCTION. YOUR FIRST GOAL IS TO ANALYZE INFORMATION RELEVANT TO THE FAIL. THERE ARE TWO SOURCES OF INFORMATION THAT WILL HELP YOU DO THIS. THE FIRST IS THE TITE CRT DISPLAY SHOWN BELOW AND THE SECOND IS THE OA/FI TEST SUMMARY FOR THE FAILED TEST. IF YOU WANT TO KNOW MORE ABOUT THE CRT DISPLAY OR SEE THE TEST SUMMARY, SELECT ACCESS TECH DATA IN THE GENERAL ACTION MENU.

TROUBLESHOOTING GOAL: Analyze information relevant to the fail.

GENERAL ACTIONS

Access Tech Data
Activate Equipment
Change Goal
Show Parallel
Cancel Current Action
Quit

EQUIPMENT ENVIRONMENT



TECH DATA ENVIRONMENT

P2 T10 S620 D1 M01 DATA

TSG 10 620
H 1 1.99997+37 SEC 1.00000-02 0.00000+00 S15-4 S14-4 S13-4

OPERATOR ACTION
1. USE DPO TO VERIFY 10 KHZ, 2.2 VP-P AT BOTH 50 OHM LOADS ON COUNTER/TIMER
2. ENTER 1 IF ONE SIGNAL IS MISSING OR 2 IF BOTH SIGNALS ARE MISSING

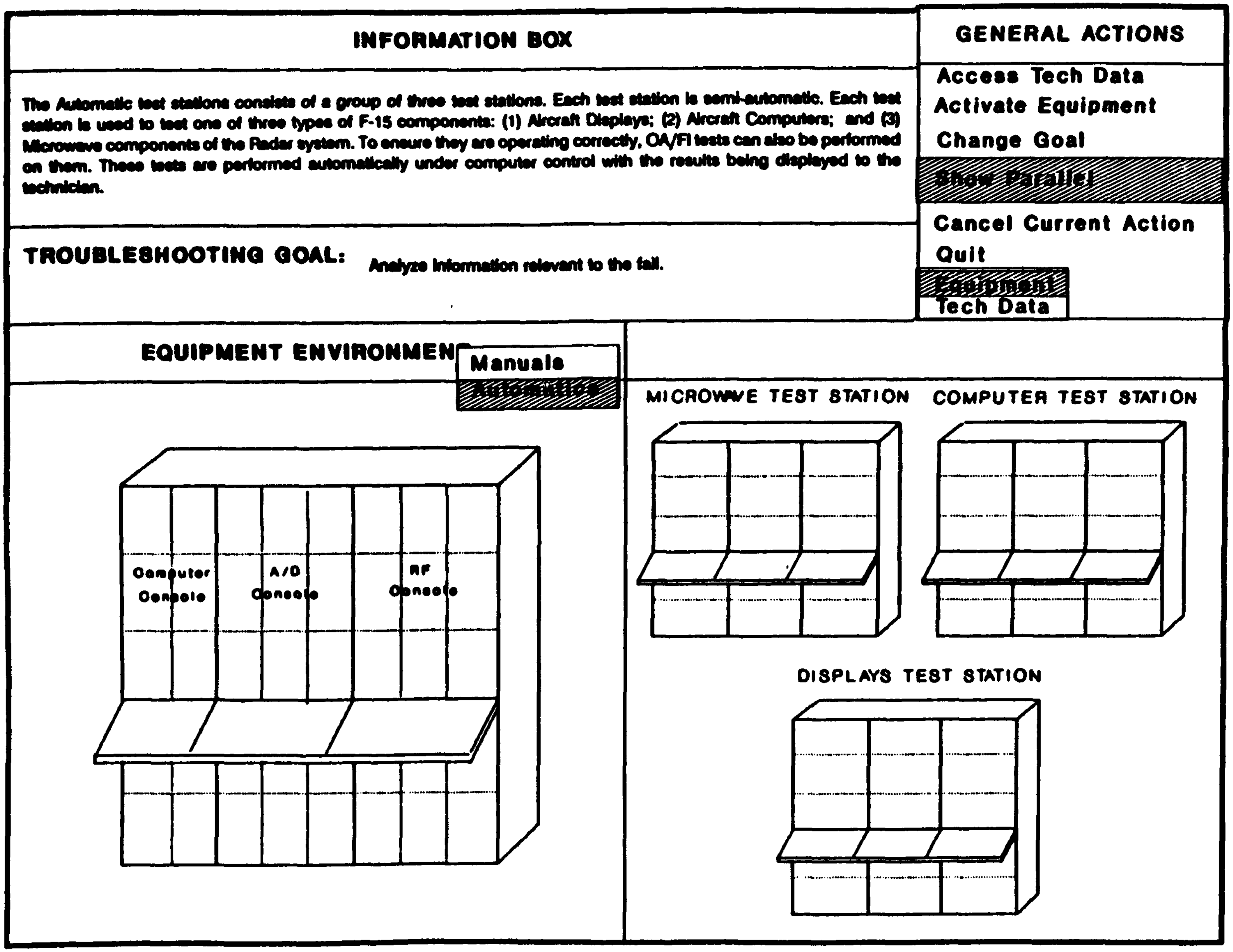
? 2

OPERATOR ACTION
1. USE DPO TO VERIFY 10 KHZ, 4 VP-P AT AT PULSE GENERATOR J108
2. ENTER 1 IF THE SIGNAL IS MISSING OR 2 IF THE SIGNAL IS PRESENT

? 2

OPERATOR INSTRUCTION
S15-4 FAILED TO SET. REFER TO TO 33D7-38-77-28-1-2 FOR FAULT ISOLATION INSTRUCTIONS.

STATION CLEARED


INFORMATION BOX
The Automatic test stations consists of a group of three test stations. Each test station is semi-automatic. Each test station is used to test one of three types of F-15 components: (1) Aircraft Displays; (2) Aircraft Computers; and (3) Microwave components of the Radar system. To ensure they are operating correctly, OA/FI tests can also be performed on them. These tests are performed automatically under computer control with the results being displayed to the technician.
TROUBLESHOOTING GOAL: Analyze information relevant to the fail.
GENERAL ACTIONS
Access Tech Data
Activate Equipment
Change Goal
Show Parallel
Cancel Current Action
Quit
Equipment
Tech Data
EQUIPMENT ENVIRONMENT
Manuals
Automatics
Computer Console
A/D Console
RF Console
MICROWAVE TEST STATION
COMPUTER TEST STATION
DISPLAYS TEST STATION

INFORMATION BOX

The Manual test stations consist of a group of three test stations. These test stations are under complete control of the technician. Each test station is used to test components from one of three functionally unique F-15 systems: (1) the Radar system (Ant TS); (2) the Communication, Navigation and Identification systems (CNI TS); and Aircraft Indicators and Controls (I&C TS). To ensure they are operating correctly, OA/FI tests can also be performed on them. However, the parameters of each test station device (i.e., stimulus, routing and measurement parameters) must be set up by the technician for each test.

TROUBLESHOOTING GOAL: Analyze information relevant to the fail.

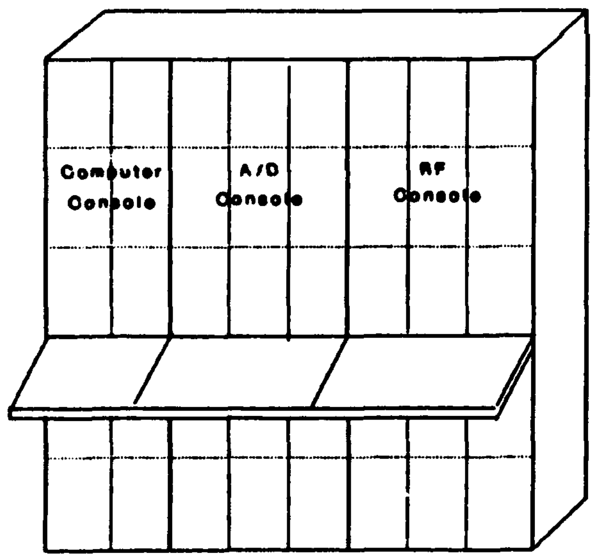
GENERAL ACTIONS

- Access Tech Data
- Activate Equipment
- Change Goal
- Show Parallel
- Cancel Current Action
- Quit

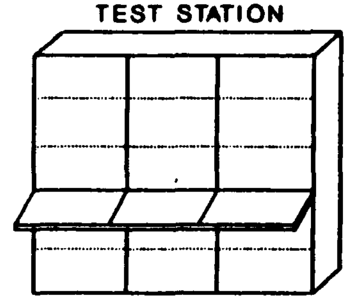
Equipment

Tech Data

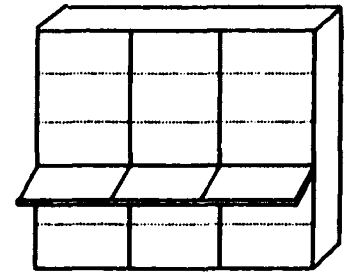
EQUIPMENT ENVIRONMENT



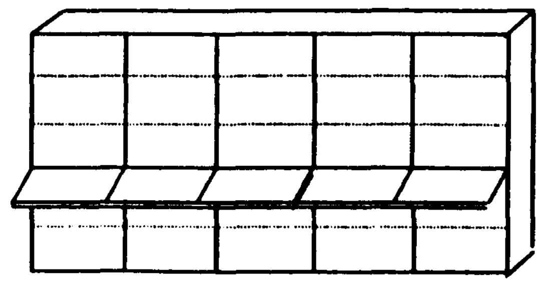
COMMUNICATION, NAVIGATION, & IDENTIFICATION TEST STATION



INDICATORS AND CONTROLS TEST STATION



ANTENNA TEST STATION



INFORMATION BOX

OA/FI tests are also performed on the Manual test stations; however, they are not part of a weekly inspection. In fact, skilled Manuals technicians rarely use OA/FI tests because of the limited information they provide. Compared to the TITE OA/FI test summary shown below, the Manuals station OA/FI tech data is much more general. For example, the level of detail stops at the CARD level, whereas the TITE OA/FI test summary specifies COMPONENTS (e.g., switches and jacks). To get COMPONENT information, the Manual technician must access schematics.

TROUBLESHOOTING GOAL: Analyze information relevant to the fail

GENERAL ACTIONS

- Access Tech Data
- Activate Equipment
- Change Goal
- Show Parallel
- Cancel Current Action
- Quit
- Equipment
- Tech Data

TECH DATA PARALLEL

- Manuals
- Automatics

OA/FI tests

Step No	Panel	Action	Normal Indication	Remedy For Abnormal Indication
183	2A2A3 UHF CNTRL PNL	j Press to illuminate STIMULUS SEL TEST switch indicator	2A2A1 FREQ CNTR 290 MHZ to 310 MHZ	Refer to step F137

OA/FI Fault Isolation tests

Step No	Panel	Action	Normal Indication	Remedy For Abnormal Indication
F137	2A2A2 RF/RMS VM	a. Observe RF MILLI-VOLTMETER b Replace A1A13	Above -5 (-15dBm)	Replace A1A10

TECH DATA ENVIRONMENT

TO 33D7-38-77-28-1-1

Table 2-15. Coaxial Switching Drawer Test Summary

DEVICE UNDER TEST		MEASUREMENT DEVICE		
DRAWER	SETUP DATA	DRAWER	SETUP DATA	LIMITS
P2T10S620D1UN01 Pulse Gen	5 Vdc output 10 us pw 100 ns TR/TF 0 Vdc offset 10 khz freq	Counter/ Timer	TI from chA to chB 100 us range	0 to 0.01s

ROUTING

PGEN: J100
ADCOAX: S15-C, S15-4, S10-2, S9-2,
S6-1, S7-6, S8-6, S14-4
PATH TO CH A INPUT:
ADCOAX: S13-4, S13-C

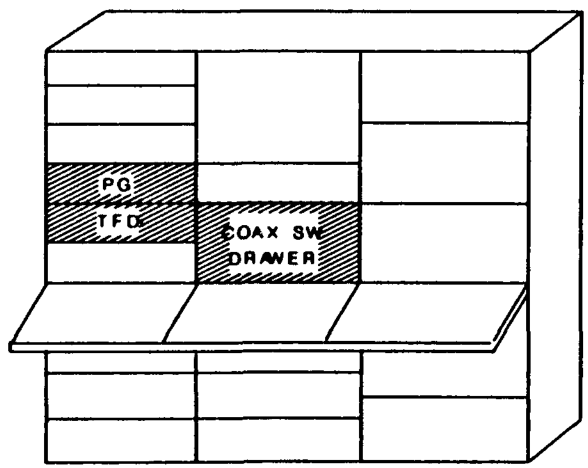
TFD: CH A INPUT
PATH TO CH B INPUT:
ADCOAX: S14-C
TFD: CH B INPUT

NOTE: High and low signals follow the same routing, but the low is carried on the shield.

INFORMATION BOX	GENERAL ACTIONS
In this section of the tech data display, signal ROUTING information is specified. The signal is being routed from the output of the Pulse Generator (PGEN), which is the STIMULUS device, through relays in the Coaxial Switching Drawer (ADCOAX) (ROUTING device) to both the CHA and CHB inputs of the Counter/Timer (TFD) (MEASUREMENT device). All three drawers are located in the Analog/Digital (A/D) Console of the TITE station.	Access Tech Data Activate Equipment Change Goal Show Parallel Cancel Current Action Quit
TROUBLESHOOTING GOAL: Analyze information relevant to the fail.	

EQUIPMENT ENVIRONMENT

A/D CONSOLE



TECH DATA ENVIRONMENT

TO 33D7-38-77-26-1-1

Table 2-15. Coaxial Switching Drawer Test Summary

DEVICE UNDER TEST		MEASUREMENT DEVICE		
DRAWER	SETUP DATA	DRAWER	SETUP DATA	LIMITS
P2T1086200… Pulse Gen	5 Vdc output 10 us pw 100 ns TR/TF 0 Vdc offset 10 khz freq	Counter/ Timer	TI from chA to chB 100 us range	0 to 0.01s

ROUTING

PGEN: J100
ADCOAX: S15-C, S15-4, S10-2, S9-8, S6-1, S7-6, S8-6, S14-4
PATH TO CH A INPUT:
ADCOAX: S13-4, S13-C

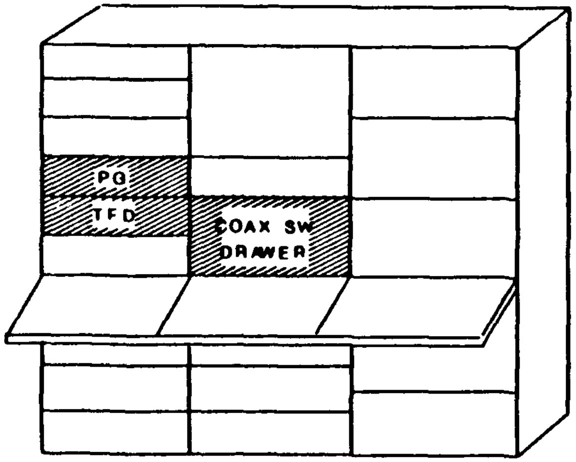
TFD: CH A INPUT
PATH TO CH B INPUT:
ADCOAX: S14-C
TFD: CH B INPUT

NOTE: High and low signals follow the same routing, but the low is carried on the shield.

INFORMATION BOX	GENERAL ACTIONS
Where can you find the parameters of the Pulse Generator's output signal? Correct! The parameters of the Pulse Generator's output signal are found in the DEVICE UNDER TEST - SETUP DATA section of the Coaxial Switching Drawer's Test Summary.	Access Tech Data Activate Equipment Change Goal Show Parallel Cancel Current Action Quit
TROUBLESHOOTING GOAL: Analyze information relevant to the fail.	

EQUIPMENT ENVIRONMENT

A/D CONSOLE



TECH DATA ENVIRONMENT

TO 33D7-38-77-28-1-1

Table 2-15. Coaxial Switching Drawer Test Summary

DEVICE UNDER TEST		MEASUREMENT DEVICE		
DRAWER	SETUP DATA	DRAWER	SETUP DATA	LIMITS
P2T10S620D1M801 Pulse Gen	5 Vdc output 10 us pw 100 ns TR/TF 0 Vdc offset 10 khz freq	Counter/ Timer	TI from chA to chB 100 us range	0 to 0.01s

----------ROUTING----------

PGEN: J100
ADCOAX: S15-C, S15-4, S10-2, S9-2,
S6-1, S7-6, S8-6, S14-4
PATH TO CH A INPUT:
ADCOAX: S13-4, S13-C

TFD: CH A INPUT
PATH TO CH B INPUT:
ADCOAX: S14-C
TFD: CH B INPUT

NOTE: High and low signals follow the same routing, but the low is carried on the shield.

INFORMATION BOX

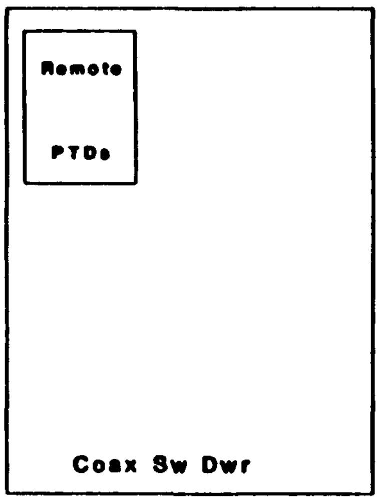
THIS TROUBLESHOOTING GOAL REQUIRES YOU TO INVESTIGATE THE SIGNAL PATH THROUGH THE ROUTING DEVICE. (DRAWER LEVEL) SINCE YOU HAVE VERIFIED THAT THE INPUTS TO THE MEASUREMENT DEVICE WERE BAD AND THE OUTPUT FROM THE STIMULUS DEVICE WAS GOOD, YOU HAVE ISOLATED THE MALFUNCTION TO THE SIGNAL ROUTING.

TROUBLESHOOTING GOAL: Investigate the signal path through the routing device.

GENERAL ACTIONS

- Access Tech Data
- Activate Equipment
- Change Goal
- Show Parallel
- Cancel Current Action
- Quit

EQUIPMENT ENVIRONMENT



TECH DATA ENVIRONMENT

TO 33D7-38-77-28-1-1

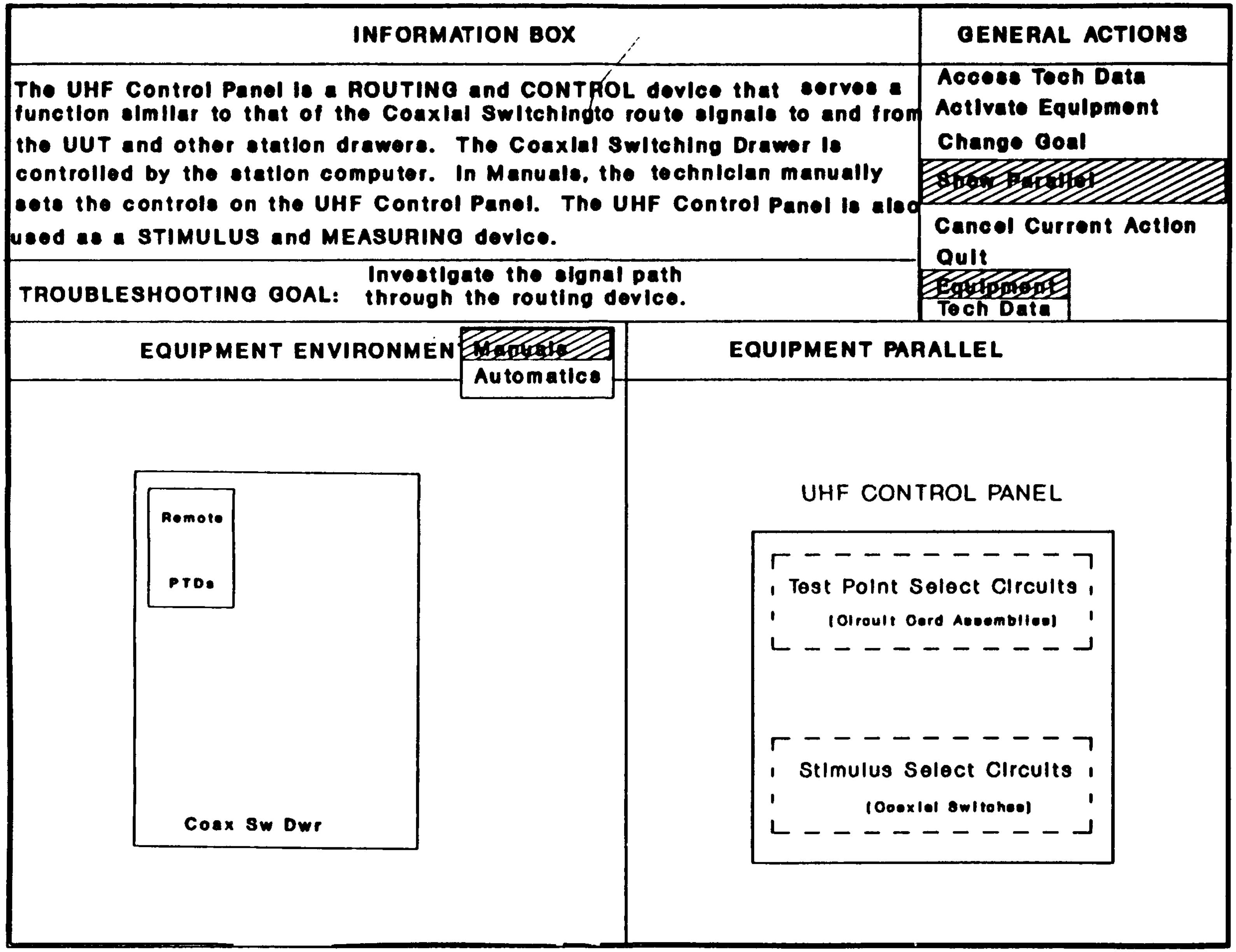
Table 2-15. Coaxial Switching Drawer Test Summary

DEVICE UNDER TEST		MEASUREMENT DEVICE		
DRAWER	SETUP DATA	DRAWER	SETUP DATA	LIMITS
P2T10S620D1M801 Pulse Gen	5 Vdc output 10 us pw 100 ns TR/TF 0 Vdc offset 10 khz freq	Counter/ Timer	TI from chA to chB 100 us range	0 to 0.01s

ROUTING

PGEN: J108
AUCOAX: S15-C, S15-4, S10-2, S9-2, S6-1, S7-4, S8-6, S14-4
PATH TO CH A INPUT:
ADCOAX: S13-4, S13-C
TPD: CH A INPUT
PATH TO CH B INPUT:
ADCOAX: S14-C
TPD: CH B INPUT

NOTE: High and low signals follow the same routing, but the low is carried on the shield.


INFORMATION BOX
The UHF Control Panel is a ROUTING and CONTROL device that serves a function similar to that of the Coaxial Switchingto route signals to and from the UUT and other station drawers. The Coaxial Switching Drawer is controlled by the station computer. In Manuals, the technician manually sets the controls on the UHF Control Panel. The UHF Control Panel is also used as a STIMULUS and MEASURING device.
TROUBLESHOOTING GOAL: Investigate the signal path through the routing device.
GENERAL ACTIONS
Access Tech Data
Activate Equipment
Change Goal
Show Parallel
Cancel Current Action
Quit
Equipment
Tech Data
EQUIPMENT ENVIRONMENT
Manuals
Automatics
Remote
PTDs
Coax Sw Dwr
EQUIPMENT PARALLEL
UHF CONTROL PANEL
Test Point Select Circuits
(Circuit Card Assemblies)
Stimulus Select Circuits
(Coaxial Switches)

INFORMATION BOX

a. You have eliminated the Counter/Timer.
b. You have eliminated the Pulse Generator.
c. You have measured the signal at S15-4, you measured 0 Vdc.
d. You have measured the signal at 81W32-P1, you measured 5 Vdc pulses.
e. You have measured resistance from S15-C to S15-4, you measured an open.

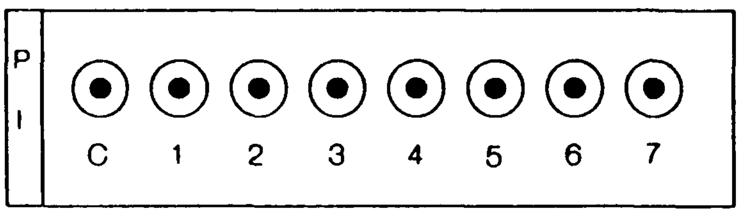
TROUBLESHOOTING GOAL: Investigate the signal path through the routing device.

GENERAL ACTIONS

- Access Tech Data
- Activate Equipment
- Change Goal
- Show Parallel
- Cancel Current Action
- Quit
- Troubleshooting
- Coaching

EQUIPMENT E

- Tests Completed
- Test Results Explained
- Options Remaining
- Preferred Next Test



S15
Coaxial Switch

TECH DATA ENVIRONMENT

TO 33D7-38-77-28-1-1

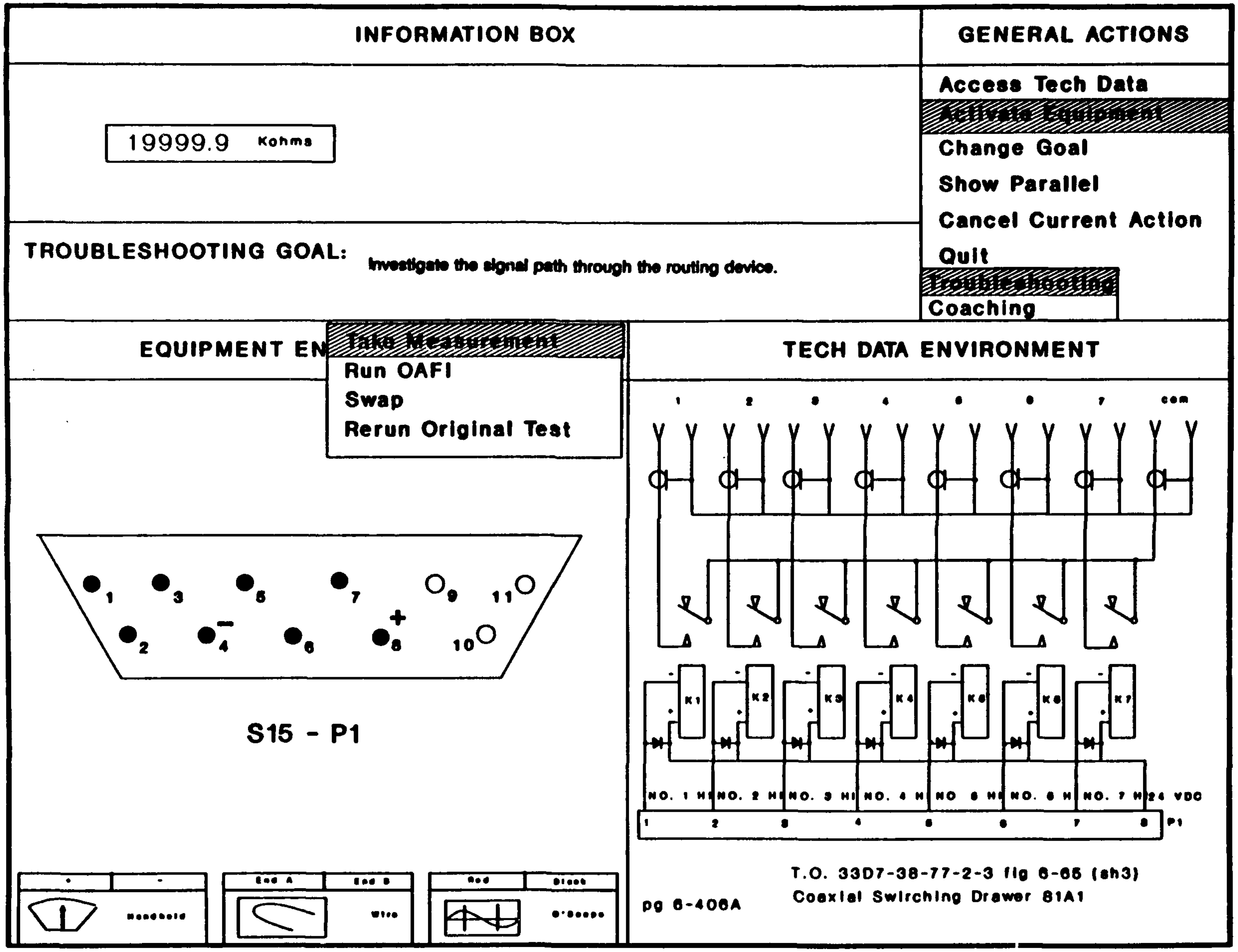
Table 2-15. Coaxial Switching Drawer Test Summary

DEVICE UNDER TEST		MEASUREMENT DEVICE		
DRAWER	SETUP DATA	DRAWER	SETUP DATA	LIMITS
P2T10S620D1MS01 Pulse Gen	5 Vdc output 10 us pw 100 ns TR/TF 0 Vdc offset 10 khz freq	Counter/ Timer	TI from chA to chB 100 us range	0 to 0.01s

-ROUTING-

PGEN: J108
ADCOAX: S15-C, S15-4, S10-2, S9-2, S6-1, S7-6, S8-6, S14-4
PATH TO CH A INPUT:
ADCOAX: S13-4, S13-C
TFD: CH A INPUT
PATH TO CH B INPUT:
ADCOAX: S14-C
TFD: CH B INPUT

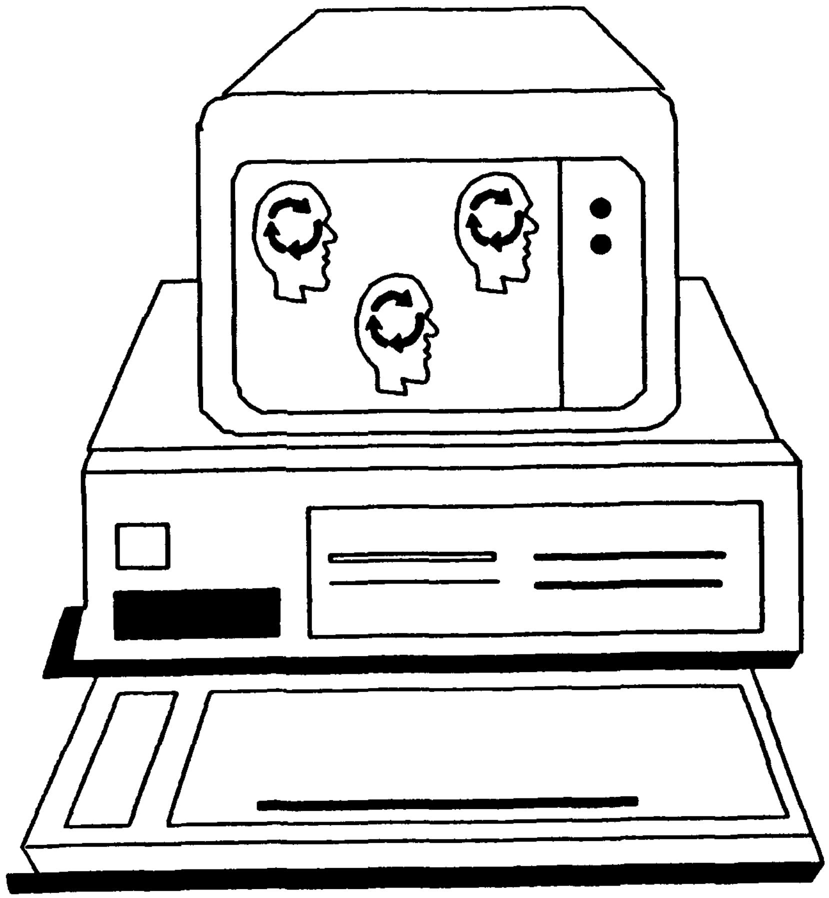
NOTE: High and low signals follow the same routing, but the low is carried on the shield.


INFORMATION BOX
GENERAL ACTIONS
19999.9 Kohms
Access Tech Data
Activate Equipment
Change Goal
Show Parallel
Cancel Current Action
Quit
Troubleshooting
Coaching
TROUBLESHOOTING GOAL:
Investigate the signal path through the routing device.
EQUIPMENT EN
Take Measurement
Run OAFI
Swap
Rerun Original Test
TECH DATA ENVIRONMENT
S15 - P1
T.O. 33D7-38-77-2-3 fig 6-65 (sh3)
Coaxial Swirching Drawer 81A1
pg 6-406A

POST-PROBLEM ACTIVITIES IN RIVTEK

- Critique of trainee's solution
  - Positive features of solution praised
  - Any violations of standard troubleshooting practices reported
  - General levels of proficiency estimated
    - System Knowledge
    - Procedural Knowledge
    - Strategic Knowledge
  - Adaptiveness level estimated
  - Dependence/independence of coaching: level of appropriateness estimated
- Alternative troubleshooting solutions presented and explained
- Activities to strengthen learning skills associated with adaptive expertise presented/scored

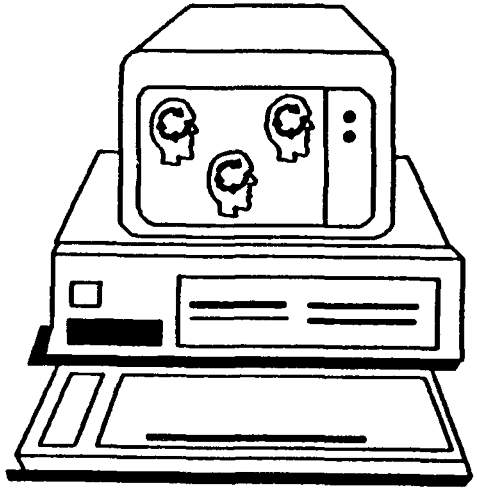
PAYOFF



Mental Tools for Thinking

PAYOFFS

- Maintenance savvy captured in tutors
  - Reasons behind decisions made explicit
  - Alternative solutions understood



- Acceleration of complex skill development
  - Restored apprenticeship learning experiences
  - Performance with understanding
  - Enhanced, stable productivity
- Performance adaptiveness
  - Flexibility under novel conditions (e.g., combat)
  - Transfer of skills to new systems, new AF organization structure
  - Reduced training demands/costs
  - Enhanced utilization of personnel

ARMY RESEARCH INSTITUTE (ARI)
FOREIGN LANGUAGE TUTOR

ARI has a program of research on technology applications for language learning. A current project has produced an interactive PC-based tutor to help teach military specific language skills and maintain general language proficiency for students at the intermediate level and above. The current tutor is in German.

INDIVIDUALIZED INSTRUCTION:

The computer program can ask questions (written or orally) and give feedback. It can analyze and understand freely-typed input by the students in the target language using natural language processing. It can diagnose and track errors in grammar and meaning and adapt the lesson automatically to the individual student's progress.

FLEXIBILITY:

The tutor includes an authoring interface which allows instructors to create new lessons. The interface is also an aid to researchers who can use the tutor to define alternative instructional strategies and test them. This interface is comprised of sample templates to be filled in and requires no programming skills.

EXTENDABILITY:

The tutors under development are designed to challenge the student to communicate and learn in the target language. Most of the software in these tutors would require only minimal changes to apply to a range of foreign language (extendability to Arabic has been demonstrated). This is primarily due to two factors: 1) the natural language processor contains reusable language universal components, and 2) the lesson authoring system (a "one-time" development cost) can be used for any language application.

FUTURE DEVELOPMENT:

A new 3-year development program will begin in 1992, with the goal of creating a "second generation" tutor that will immerse the student in the language environment through interactive dialogs utilizing natural language processing, speech recognition systems, and dynamic graphics. Spanish and Arabic are the target languages.

ARI POCs: Dr. Melissa Holland, Team Leader
Dr. Jonathan Kaplan, Dr. Michelle Sams, Dr. Cathie Alderks, Mr. Rich Maisano
(703) 274-5540 AV 284-5540

ARMY RESEARCH INSTITUTE

ADVANCED TECHNOLOGY FOR LANGUAGE LEARNING

TRAINING RESEARCH LAB

ADVANCED LANGUAGE LEARNING TECHNOLOGY TEAM

Dr. Melissa Holland, Team Leader
Dr. Jonathan Kaplan, Dr. Michelle Sams, Dr. Cathie Alderks, Mr. Rich Maisano
(703)274-5540 AV 284-5540

BACKGROUND

ARMY NEED:

** Assist Military Intelligence & Special Forces linguists acquire and maintain language proficiency

- * In school, few resources to teach job specific language skills
- * In field, constraints exist on training time and resources for language maintenance

ARI's RESPONSE:

** Develop an interactive and adaptive computer tutor

- * To provide individualized instruction for MI & SOF linguists
- * To provide a vehicle for ARI researchers to investigate how to improve foreign language acquisition and retention

ADVANCED TECHNOLOGY FOR LANGUAGE LEARNING

PROGRAM GOALS:

Increase the preparedness of military linguists by developing "realistic immersion" environments through user-friendly state-of-the-art technology.

Conduct research on second language acquisition and retention with the aim of optimizing the tutor's pedagogical and technological approach.

MAJOR PRODUCTS:

FIRST GENERATION TUTOR
(German, available August 1992)

SECOND GENERATION TUTOR
(Spanish & Arabic, 3 year program starts May 1992)

LANGUAGE SKILLS

COMPREHENSION (Recognition)	READING	LISTENING
PRODUCTION (Recall)	WRITING	SPEAKING

Computer-assisted Language Learning

WRITING

natural language processing
key word matching
string matching

SPEAKING

connected speech -> action or discourse results
speak words/short phrases -> action results
speak words/short phrases -> pronunciation feedback
listen -> pronounce -> repeat

Goal is to communicate.

OUTSTANDING FEATURES OF TUTOR

* INDIVIDUALIZED INSTRUCTION

Capability provided by natural language processor

- **Parses full sentences input by students**
- **Analyzes grammatical errors**

Capability provided by tutor program

- **Develops a profile of student's strengths and weaknesses**
- **Adapts lessons to the individual student**

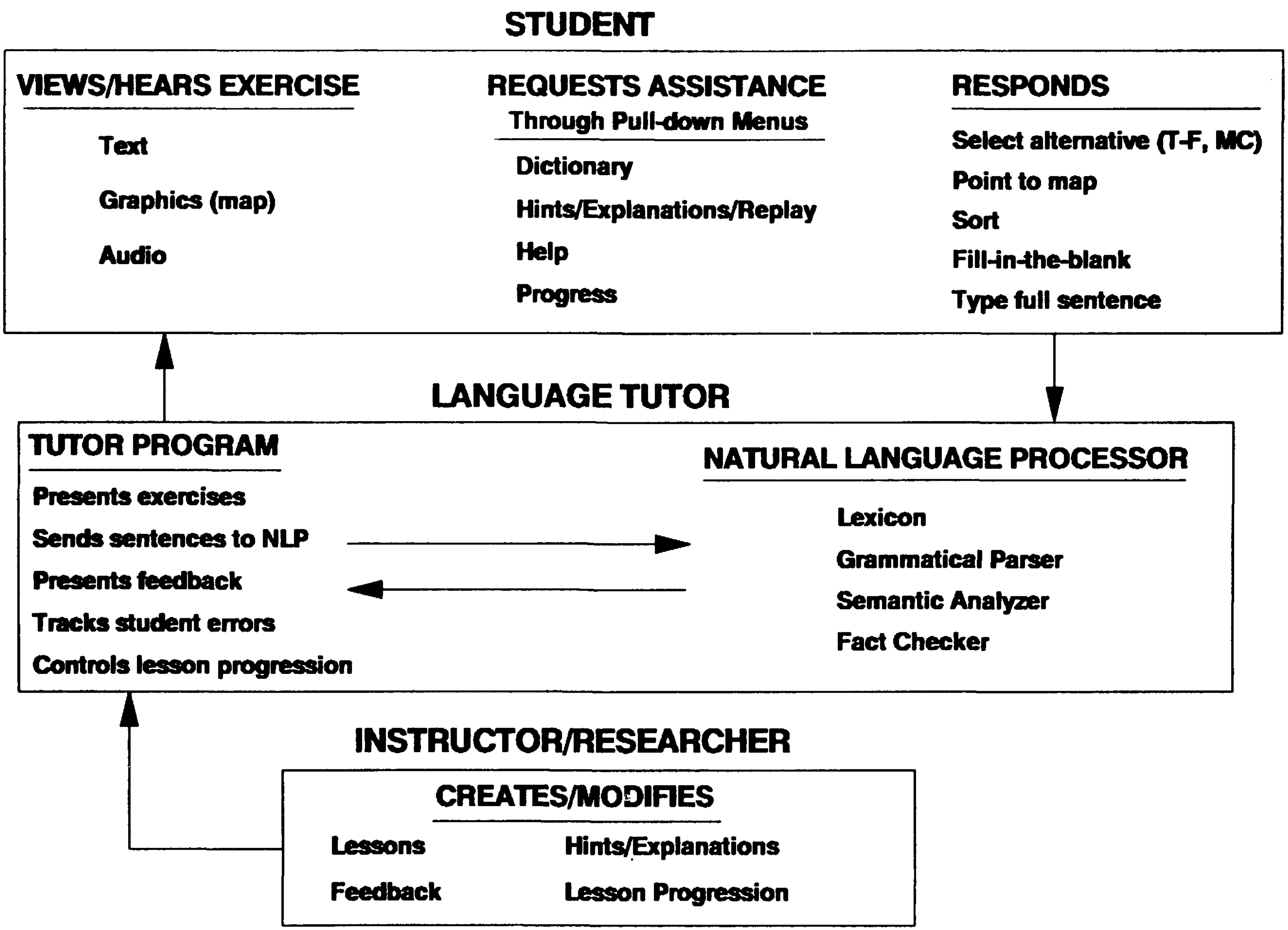
* FLEXIBILITY

Authoring system for instructors (requires no programming skills)

- **Lessons, feedback, hints, lesson progression rules**

* EXTENDABILITY

Parser is based on language universal principles with "switches" that change the parameters for different languages


STUDENT
VIEWS/HEARS EXERCISE
Text
Graphics (map)
Audio
REQUESTS ASSISTANCE
Through Pull-down Menus
Dictionary
Hints/Explanations/Replay
Help
Progress
RESPONDS
Select alternative (T-F, MC)
Point to map
Sort
Fill-in-the-blank
Type full sentence
LANGUAGE TUTOR
TUTOR PROGRAM
Presents exercises
Sends sentences to NLP
Presents feedback
Tracks student errors
Controls lesson progression
NATURAL LANGUAGE PROCESSOR
Lexicon
Grammatical Parser
Semantic Analyzer
Fact Checker
INSTRUCTOR/RESEARCHER
CREATES/MODIFIES
Lessons
Feedback
Hints/Explanations
Lesson Progression

SECOND GENERATION ATTRIBUTES

TECHNOLOGIES and DESIGN:

* Utilize relevant technologies (e.g., voice recognition), where possible
* Natural language processing (NLP) integrated with ITS/ICAI
* Based on language universal principles for extendability
* Dynamic graphics and interactive dialogs simulating second language immersion
* Capability to alter feedback mechanisms, track student performance, and diagnose classes of errors
* Easy reconfiguration (by a non-programmer) along selected dimensions for research purposes and lesson alteration

RESEARCH: POSSIBLE ISSUES TO BE EXAMINED

COGNITIVE ASPECTS

** Theoretical framework and cognitive model of foreign language acquisition and retention

* Immersion variables (e.g., overt response to input -> dialog, graphics animation)

* Cognitive demands of task (e.g., production vs. comprehension)

INSTRUCTIONAL APPROACH

* Construction of lessons & tests (e.g., problem solving, multiple-choice)

* Instructional design (e.g., presentation of linguistic rules, response dependent lesson branching)

* Error feedback (e.g., promote discourse & stop only on critical errors, diagnosis & prescription)

FORMAT VARIABLES

* Screen layout, color, graphics

* Input formats

* Speech recognition/production

CR[underline]

CREW, GROUP AND UNIT TRAINING

Update of AF ISD Process:
Major Conrad Bills

Team Decision-Making Training (Update)
Dr. Eduardo Salas
(No hard copies available)

INTRODUCTION

GOALS OF BASELINE ANALYSIS

- **LOOK AT:**
  - **CURRENT EMERGING INSTRUCTIONAL DESIGN PROCESSES**
  - **ADVANCES IN LEARNING THEORY**
  - **HIGH-TECH TRAINING SYSTEMS**
  - **AUTOMATED ISD TOOLS**
- **RECOMMEND CHANGES**

SUMMARY OF APPROACH AND FINDINGS

APPROACH

1. **SURVEY THROUGH QUESTIONNAIRE**
2. **INTERVIEWS**
3. **OBSERVATION**
4. **LITERATURE REVIEW**

SUMMARY OF APPROACH AND FINDINGS

OVERALL RESULTS AND IMPLICATIONS

1. STRENGTHS OF CURRENT AIR FORCE PROCESS

a. The Process Itself
b. General Architecture

SUMMARY OF APPROACH AND FINDINGS

OVERALL RESULTS AND IMPLICATIONS (Continued)

2. LIMITATIONS OF CURRENT PROCESS

- a. Adaptibility
- b. Follow letter rather than the intent
- c. Excessive paperwork
- d. Information is too complex
- e. Information is outdated
- f. Lacks information on affective domain
- g. Lacks detail on cognitive domain

SUMMARY OF APPROACH AND FINDINGS

OVERALL RESULTS AND IMPLICATIONS (Continued)

3. SUGGESTIONS FOR IMPROVEMENTS

a. **Reduce paperwork**
b. **Provide information in a more comprehensible manner**
c. **Provide information on affective domain**
d. **Provide information on cognitive domain**

DETAILED RESULTS OF THE SURVEY

- TARGET AUDIENCE DESCRIPTION BY APPLICATION

- SUMMARY OF FINDINGS

  - ACQUISITION
  - FLYING/AIRCREW
  - EDUCATION
  - TECHNICAL/MAINTENANCE

REVISION OF AIR FORCE ISD

RECOMMENDATIONS

1. ADAPT SYSTEMS APPROACH
2. ISD IS TOTAL QUALITY PROCESS
3. DEVELOP SEPARATE GUIDELINES
    - ACQUISITION
    - FLYING/AIRCREW
    - TECHNICAL/MAINTENANCE
4. DEVELOP "HOW TO'S"
5. ESTABLISH TECHNOLOGY CLEARING HOUSE AND "WHAT WORKS"
6. ESTABLISH 1-800 CENTRAL FACILITY

REVISION OF AIR FORCE ISD

RECOMMENDATIONS

NEEDS:

- **ACCESSIBILITY**
- **FLEXIBILITY**
- **CURRENCY**
- **AUTOMATION**

REVISION OF AIR FORCE ISD

RECOMMENDATIONS

MODEL FUNCTIONAL REQUIREMENTS

UNIQUE PERFORMANCE REQUIREMENTS

- **ACQUISITION: INTERRELATE ENGINEERING AND TRAINING INFORMATION**
- **FLYING/AIRCREW: INTEGRATE PSYCHOMOTOR, PROCEDURAL, AND COGNITIVE SKILLS IN REAL TIME**
- **TECHNICAL/MAINTENANCE: DIAGNOSTIC PROBLEM SOLVING**

REVISION OF AIR FORCE ISD

TOP-LEVEL TRAINING SYSTEM FUNCTIONS

- **ANALYSIS/DESIGN**
- **DEVELOPMENT**
- **DELIVERY**
- **MANAGEMENT/ADMINISTRATION**
- **SUPPORT**
- **EVALUATION**
- **QUALITY ASSURANCE**

REVISION OF AIR FORCE ISD

RECOMMENDATIONS

TOTAL QUALITY MANAGEMENT PROCESS

- **BELIEFS ABOUT RELATIONSHIP BETWEEN QUALITY AND COSTS**
- **TO IMPROVE RESULTS, FOCUS ON PROCESS, NOT OUTCOMES**

REVISION OF AIR FORCE ISD

RECOMMENDATIONS

- **INPUT FROM TOTAL QUALITY MANAGEMENT**

  - CUSTOMER
    - KNOWING AND SATISFYING

  - QUALITY
    - DEFINED BY CUSTOMER, ULTIMATE MEASURE OF VALUE

  - CONTINUOUS PROCESS IMPROVEMENT
    - CUSTOMER EXPECTATIONS RISE, FOCUS ON PROCESS

  - PEOPLE
    - TEAMS, COMMON VISION. TO ACHIEVE ORGANIZATION'S OBJECTIVES, COUPLE AUTHORITY WITH RESPONSIBILITY

REVISION OF AIR FORCE ISD

RECOMMENDATIONS

FORMAT:

- **AFM 50-2**
- **AFP 50-68**

(3 VOLUMES AND EXECUTIVE SUMMARY)

REVISION OF AIR FORCE ISD

NEXT-PHASE ACTIVITIES

PRODUCTS:

- **AFM 50-2**
- **AFP 50-68**
  - EXECUTIVE SUMMARY
  - VOLUME 1 - ACQUISITION
  - VOLUME 2 - FLYING/AIRCREW
  - VOLUME 3 - TECHNICAL/MAINTENANCE

REVISION OF AIR FORCE ISD

PROCESS:

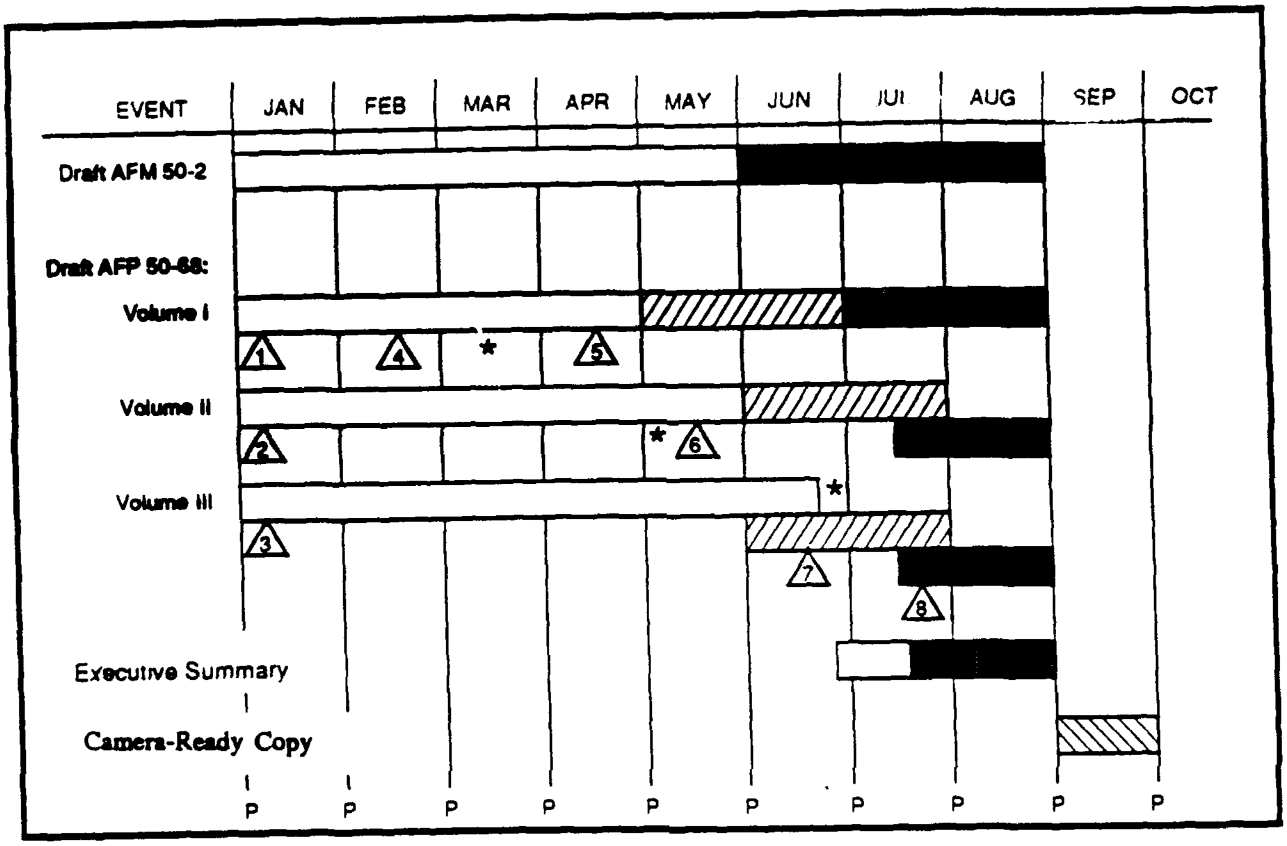
DESIGN/DEVELOP DRAFTS

FORMATIVE EVALUATION

REVISE DRAFTS

PREPARE CAMERA-READY COPY

REVISION OF AIR FORCE ISD



LEGEND

- SwRI Work Effort
- Government Review
- Conduct Formative Evaluations
- SwRI Revision Effort
- Camera-Ready Copy
- * Technical Interchange Meeting
- P Monthly Progress Report
- △ Trips

TRIPS:

1. Wright-Patterson (ASD)
2. Luke AFB
3. Lowry TTC
4. Edwards AFB
5. Wright-Patterson and/or Edwards AFB
6. Luke AFB
7. Lowry TTC
8. Wright-Patterson

POLICY FLOW

POLICY

(AFR 50-XX)

↓

GUIDANCE

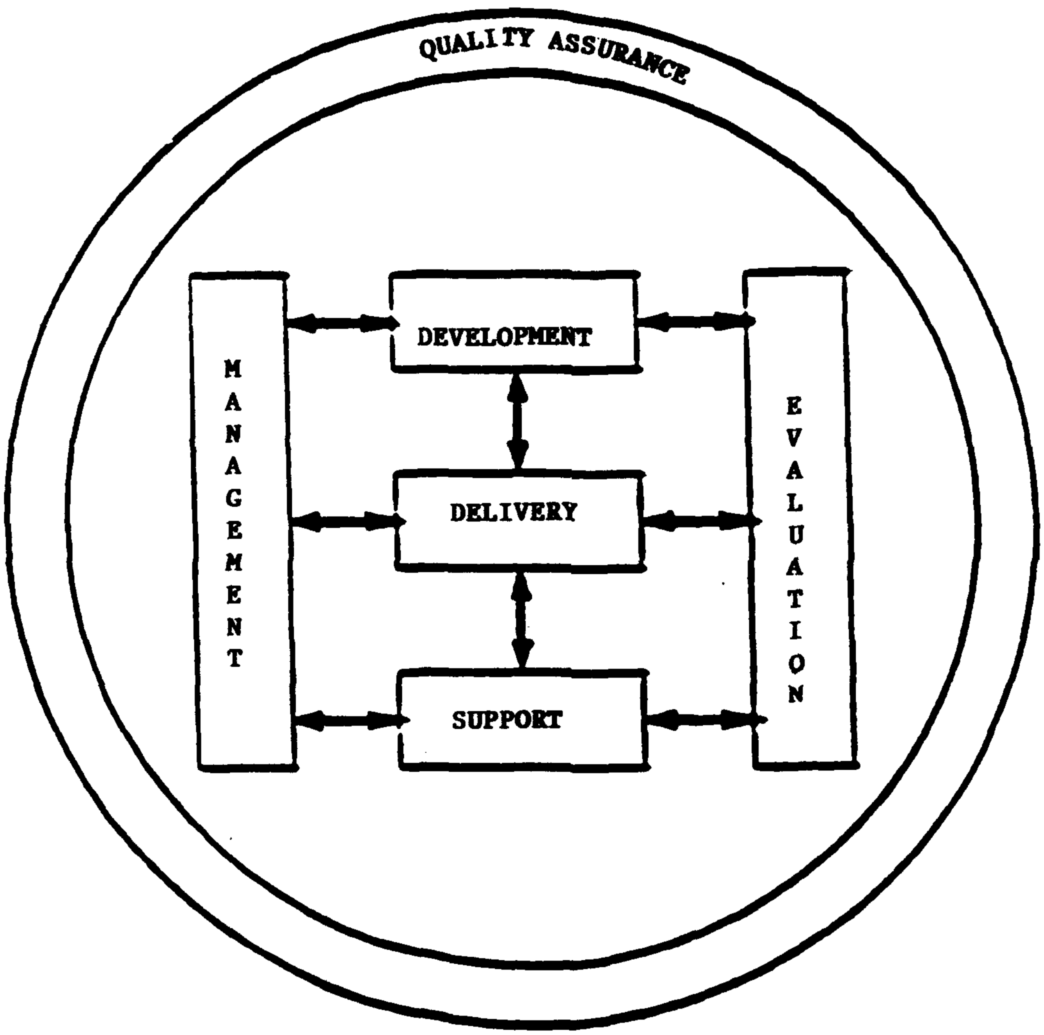
(AFM 50-2)

↓

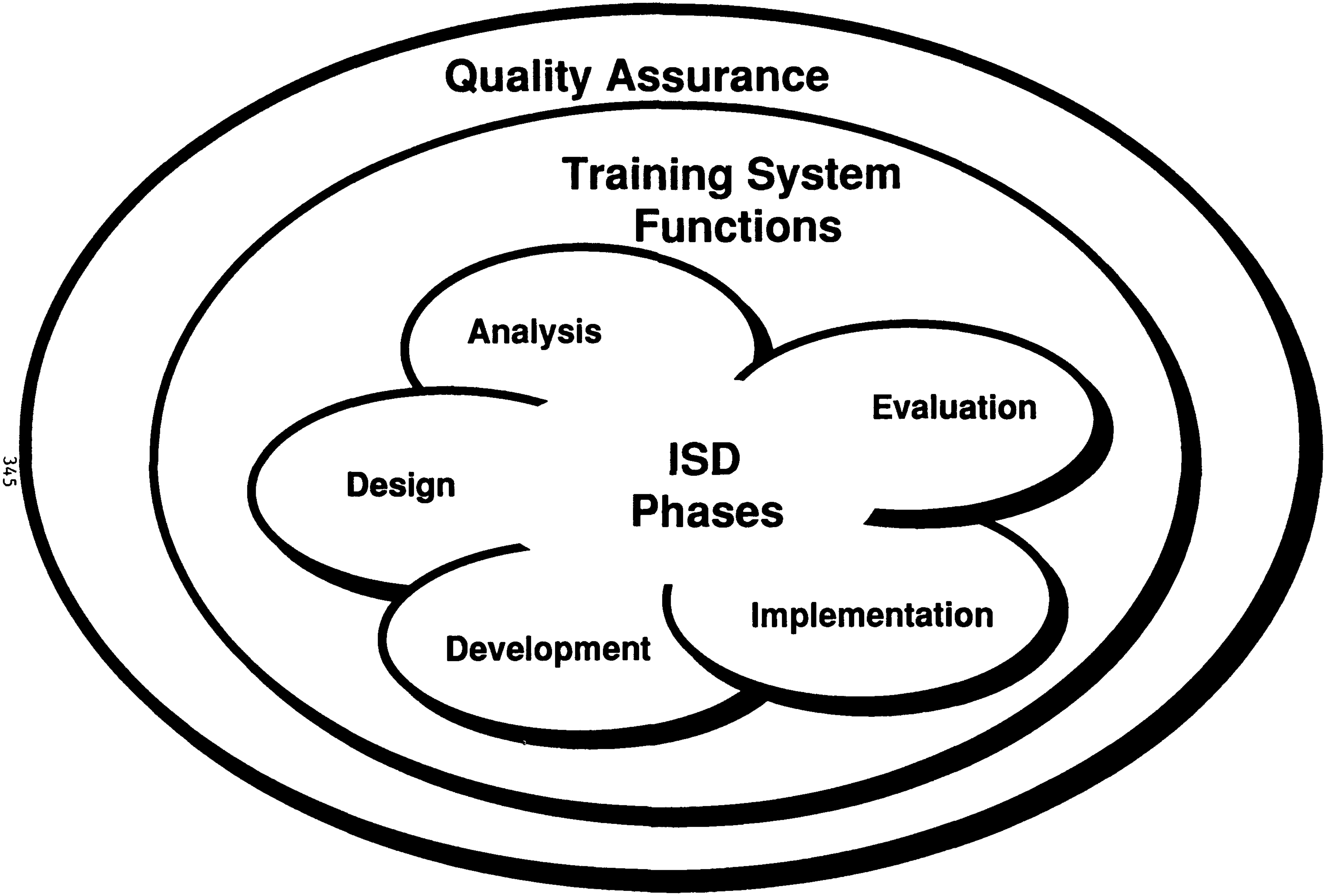
HOW TO

(AFP 50-68)

EXECUTIVE SUMMARY	TOOLS/WHAT WORKS	ACQUISITION	ICW MGT GUIDE	ICW DECISION GUIDE	
ICW DEVELOP GUIDE	ICW SELECTION GUIDE	FLYING TRAINING	TECHNICAL TRAINING	P ME	OJT



Training System Functional Model


Quality Assurance
Training System Functions
ISD Phases
Analysis
Design
Development
Implementation
Evaluation

TRAINING DESIGN AND EVALUATION

Instructional, Planning and Evaluation Issues

Instructional Strategies for Logistic
Command and Control:
Captain Reynold Hioki

Distance Learning:
Mr. Dennis Gettman
(No hard copies available)

Training Technology Technical Group (T2TG)

Desktop Training for Logistics Command and Control

Capt Reynold Hioki
AL/HRTC
25 Mar 92

PROBLEM STATEMENT

- Limited training opportunities for required complex, time/risk-critical decision-making.
  - Expense and other limitations of exercises
  - Changing threat environment
  - Personnel changeover
  - Use of battle staff augmentees
  - Inadequate knowledge about effective instructional strategies for complex decision making
  - Lack of validated training outcomes

- Sponsor: HQ USAF/LGXX
- User: HQ AFLC

OBJECTIVE

Develop instructional strategies for complex decision-making domains

Develop Desktop Training System for training complex decision-making skills

PAYOFFS

Effective individualized training for logistic battle staff personnel

PRODUCTS

Validated instructional strategies

Desktop Training System prototype

OBJECTIVE

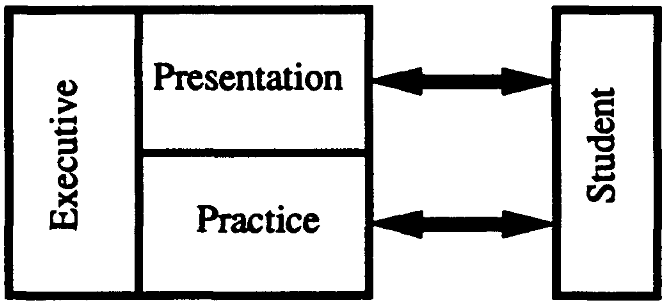
Develop instructional strategies for complex decision-making domains designed to instruct:

- -- concepts/facts
- -- rules/procedures
- -- principles/relations

Develop a desktop training system prototype for training of complex decision-making that includes:

- -- presentation capability
- -- simulation capability

SYSTEM ARCHITECTURE



PAYOFFS

Provide effective complex decision-making training for individual battle staff personnel:

- **-- when needed**
- **-- where needed**
- **-- at lower cost**

PRODUCTS

Validated instructional strategies

- -- literature-based
- -- contractor sponsored symposium
- -- experimentation

ITS prototype

- -- object-based, graphical user interface
- -- adaptive to individual student needs
- -- presentation and practice capability

SCIENTIFIC METHODOLOGY

Instructional methodology

- -- training requirements analysis
- -- literature review
- -- instructional methodology symposium
- -- field evaluation
- -- experimentation

ITS prototype

- -- instructional methodology
- -- rapid-prototyping approach
- -- object-based
- -- field evaluation
- -- experimentation

WRAP-UP

Training Design and Evaluation
Summary - Mark Teachout
(No hard copies available)

CREW, GROUP, UNIT AND TEAM

Dr. Eduardo Salas

ADVANCED TRAINING TECHNOLOGY

Dr. Ray Perez

T2TG

Crew, Group, Team, & Unit Training Technology

Eduardo Salas & Frank Moses
Co-Chairs

- Session I was entirely devoted to a discussion of a DMSO proposal submitted by ARI (lead), NTSC, and Armstrong Lab. The discussion was led by Frank Moses. He outlined the objectives of the project and the products. The proposed work is to exploit "SIMNET-like" technology and demonstrated the efficacy of different training strategies. He also showed a videotape recreating the Battle of 73 Easting.

- The topic for Session II was aircrew coordination training (ACT). There was a presentation given by Major Woodruff on a Tabletop Aircrew Coordination trainer. This is a low-fidelity PC based flight simulator that allows crews to practice teamwork skills. It generated lots of interest and discussion. Then, David Baker and Randy Oser from NTSC updated the group on recent advances of the ACT research. They focused their discussion on organizational issues in ACT and integration of ACT to technical skills. Finally, Judith Orasanu (NASA-Ames) gave a summary of current work that they are supporting on aircrew coordination and presented some data on her research.

- The last session was a presentation by Major Bills on the AF ISD work. He updated the group on what has been done and where the work is going.

Summary Advanced Training Technology Subgroup of the T2TG

The Advanced Training Technology subgroup met on the 24 & 25 March 1992. The thirteen attendees for this session represented both bench scientists and users. They represented all the major laboratories in the three services (NRL, ARI, AFHRL, NTSC, NPDRC, ONR). The theme of the five paper presentations of this meeting was research on "Virtual Reality Its Application to Training and Intelligent Tutors." Five papers were presented by Scientists from the service laboratories (ARI, AFHRL, NTSC, NPDRC). The guest discussant for these presentations was Dr. Denis Breglia from NTSC. Each presentation was followed by a discussion led by Dr. Perez, Ms. Dickieson, and Dr. Breglia. The meeting was co-chaired by Dr. Perez and Ms. Dickieson, Ms. Dickieson is the incoming chair.

Dr. Richard Thurman (AFHRL) presented his research on the use of Virtual Reality (VR) technology to enhance pilot tactical skills. He was followed by a presentation by Dr. Bruce Knerr (ARI) on the Army's efforts to generate training requirements for the use of Virtual Reality technology in the Army's future Close Combat Tactical Trainer. Dr. Joseph Psotka (ARI) presented a paper on the use of hyper-media to enhance visual problem-solving in a Virtual Reality environment. Dr. Psotka pointed out the similarities in considerations for VR and Hypertext applications. He was followed by a paper presented by Dr. Ellen Hall (AFHRL) on the Air Force's tutor for the family of skills. This paper in turn was followed by Dr. Wisher (ARI) who described his research on cognitive modeling of the acquisition of morse code. Dr. Michelle Sams (ARI) presented the work they are doing on a Foreign Language Tutor. The objective of Dr. Hall and Dr. Sams' projects is to design, develop, and implement intelligent tutors.

The paper presentations and questions were followed by a discussion and suggestions of future topics for Advanced Training Technologies Subgroup meetings.

A summary of conclusions of the VR research and comments made by the group follow.

o Little or no instructional design theory exists to go along with and guide the use of VR technology.

o Hardware/software hasn't reach sufficient level of maturity for commercial or military applications.

- Commercial applications will produce the largest technical gains in the development of VR.

- No economies of scales exists for VR.

o More research is needed to answer the following questions and issues.

- To what degree do we need this technology (what current training problem will it solve)?

- We need a better understanding of spatial orientation before we can effectively design and use VR technology.

- We need better theories and definitions of visual metaphors for capturing data.

o Government needs to be more proactive in helping industry define its needs.

In general, advances in training technology, including the work on the design of Intelligent tutors, need to address the requirement for personnel to perform increasingly complex and difficult tasks and possess a wide range of skills.

Topics for next meeting:

o Distance Learning/Distance Education

o Virtual Environments

o Applied Technologies

It was suggested that we invite DMSO to attend and have personnel from Disney World brief on their applications of VR. Everyone agreed that we should always have included in our sessions, various projects to be briefed that are beyond the conceptual stage and can report data.

In sum, the meeting was very successful as measured by the enthusiasms of the participants and their representativeness. At least one bench scientist from each of the services labs was in attendance.

Ray S. Perez
Jan Dickieson
Co-Chairpersons Advanced
Training Technologies Subgroup

ADVANCE TRAINING TECHNOLOGIES ATTENDEES

NAME	AGENCY/SYMBOL	PHONE
Ray Perez	ARI, PERI-IIB	C (703) 274-8694 DSN 284-8694
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John E. Buckley	TRADOC-DCST	AV 680-5535
Wes Regian	AL/HRTI	AV 240-2034
Jim Fleming	AL/HRTI	AV 240-2034
Richard Thurman	AL/HRAU	DSN 474-6561
Philip Miller	436STS/OLED Edwards AFB	DSN 525-8767
Kevin Dixon	HQATC/XPCR	DSN 487-3390
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Reynold Hiola	AL/HRTC	DSN 240-2981
Meryl Baker	NPRDC, 01G	C (619) 553-0785 AV 553-0785
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Denis Breglia	NTSC-CODE 251	C (407) 380-8159 AV 960-8159
Carl Driskell	US Army STRICOM (Formerly PM TRADE) AMCPM-TND-E	C (407) 380-4348 DSN 960-4348

T2TG REGISTRATION LIST

ATTENDEES

BAKER, DAVID DR.	NTSC, Orlando, FL
BAKER, MERYL DR.	NPR&DC, San Diego, CA
BILLS, CONRAD G. MAJ	ASD/YTEE, Wright-Patterson AFB, OH
BREGLIA, DENIS MR.	NTSC, CODE 251, Orlando, FL
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CARROLL, LYNN LTC	ATRD, Williams AFB, AZ
CHAMBERLAIN, MARTY CAPT	ONR, Arlington, VA
CRAWFORD, ALICE MS.	NPS, Monterey, CA
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DIXON, KEVIN CAPT	ATC/XPCR, Randolph AFB, TX
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DRISKELL, CARL MR.	PM-TRADE, Orlando, FL
ELLIS, JOHN DR.	NPRDC, San Diego, CA
FLEMING, JIM MR.	AL/HRTI, Brooks AFB, TX
GETTMAN, DENNIS MR.	AL/HRTC, Brooks AFB, TX
GRAY, THOMAS DR.	AL/HRA, Williams AFB, AZ
HALL, ELLEN DR.	AL/HRMJC, Brooks AFB, TX
HIOKI, REYNOLD CAPT	AL/HRTC, Brooks AFB, TX
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ORASANU, JUDITH	NASA-ARC, Moffett Field, CA
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THURMAN, RICHARD DR.	AL/HRAU, Williams AFB, AZ
PEREZ, RAY DR.	ARI, Alexandria, VA
PSOTKA, JOE DR.	ARI, Alexandria, VA
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SALAS, EDUARDO DR.	NTSC, Orlando, FL
SAMS, MICHELLE DR.	ARI, Alexandria, VA
SEIDEL, ROBERT J. DR.	ARI, Alexandria, VA
SINE, DON CDR	ATC, Dahlgren, VA
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